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TECHNICAL REPORT NO. 3-630

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

Report 4

by

C. R. Kolb

W. K. Dornbusch, Jr.

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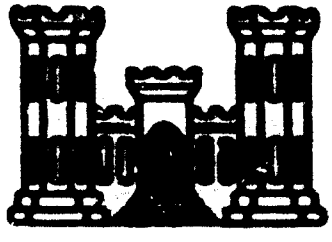

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Volume II

June 1966

Sponsored by

U. S. Army Materiel Command

Project No. 1-V-0-25001-A-131

Conducted by

U. S. Army Engineer Waterways Experiment Station

CORPS OF ENGINEERS

Vicksburg, Mississippi

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RAIN IN THE MIDDLE EAST DESERT

AIN FACTOR AND ANALOG MAPS

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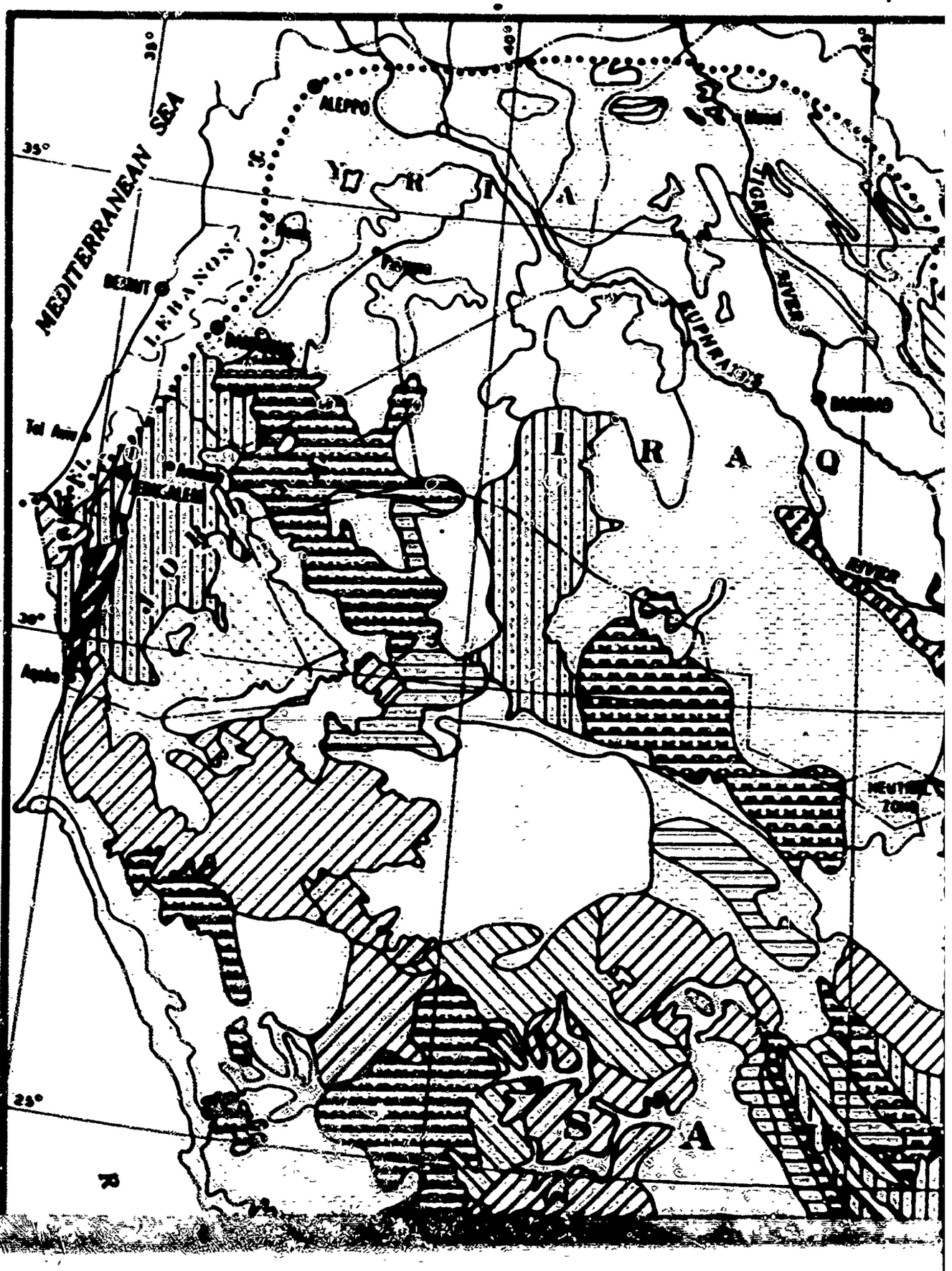
MEDITERRANEAN SEA
ALEPPO
BEIRUT
L. LEBANON
Tel Aviv
Amman
Aqaba
TIGRIS RIVER
EUPHRATES
BAGHDAD
NEUTRAL ZONE
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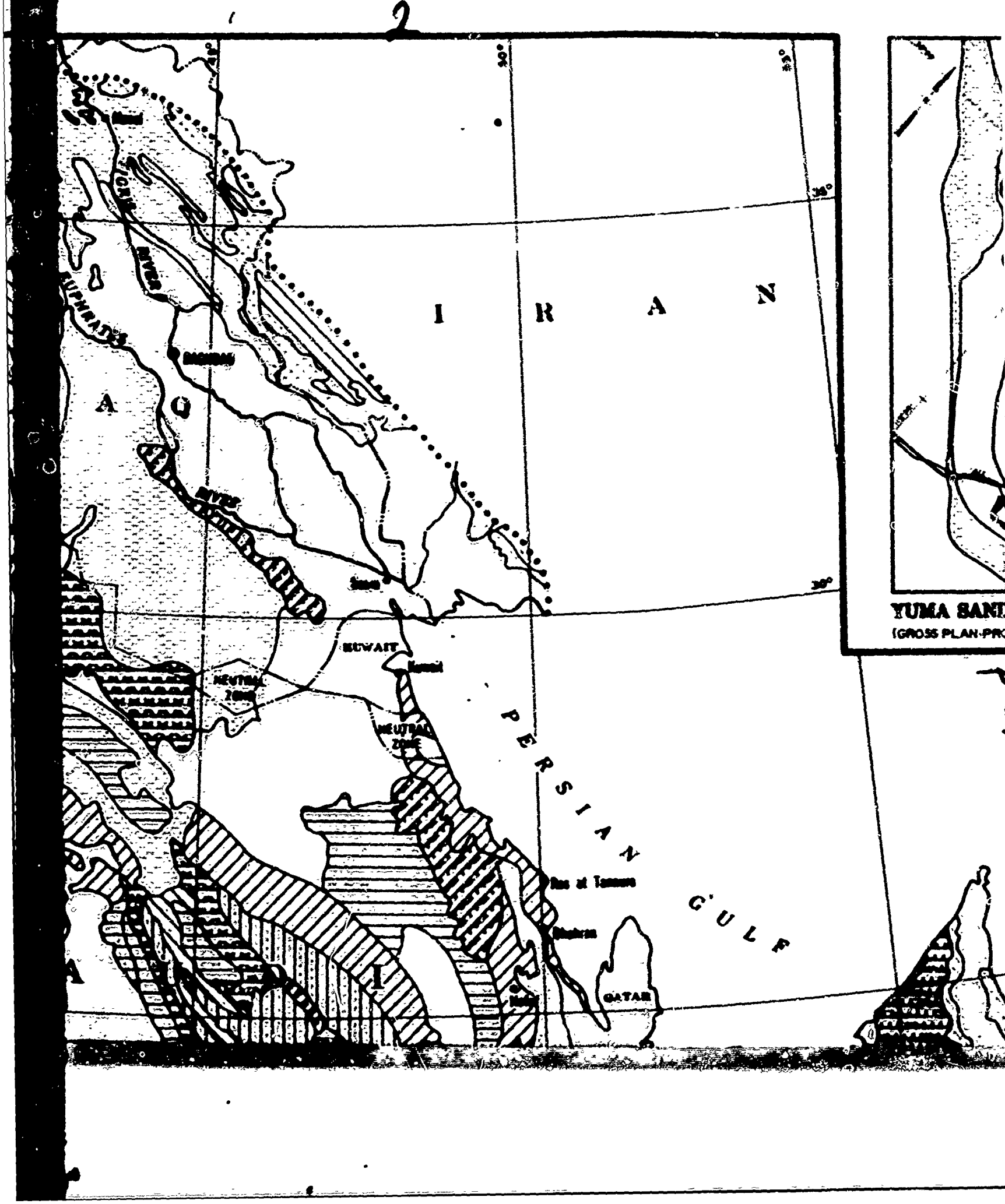
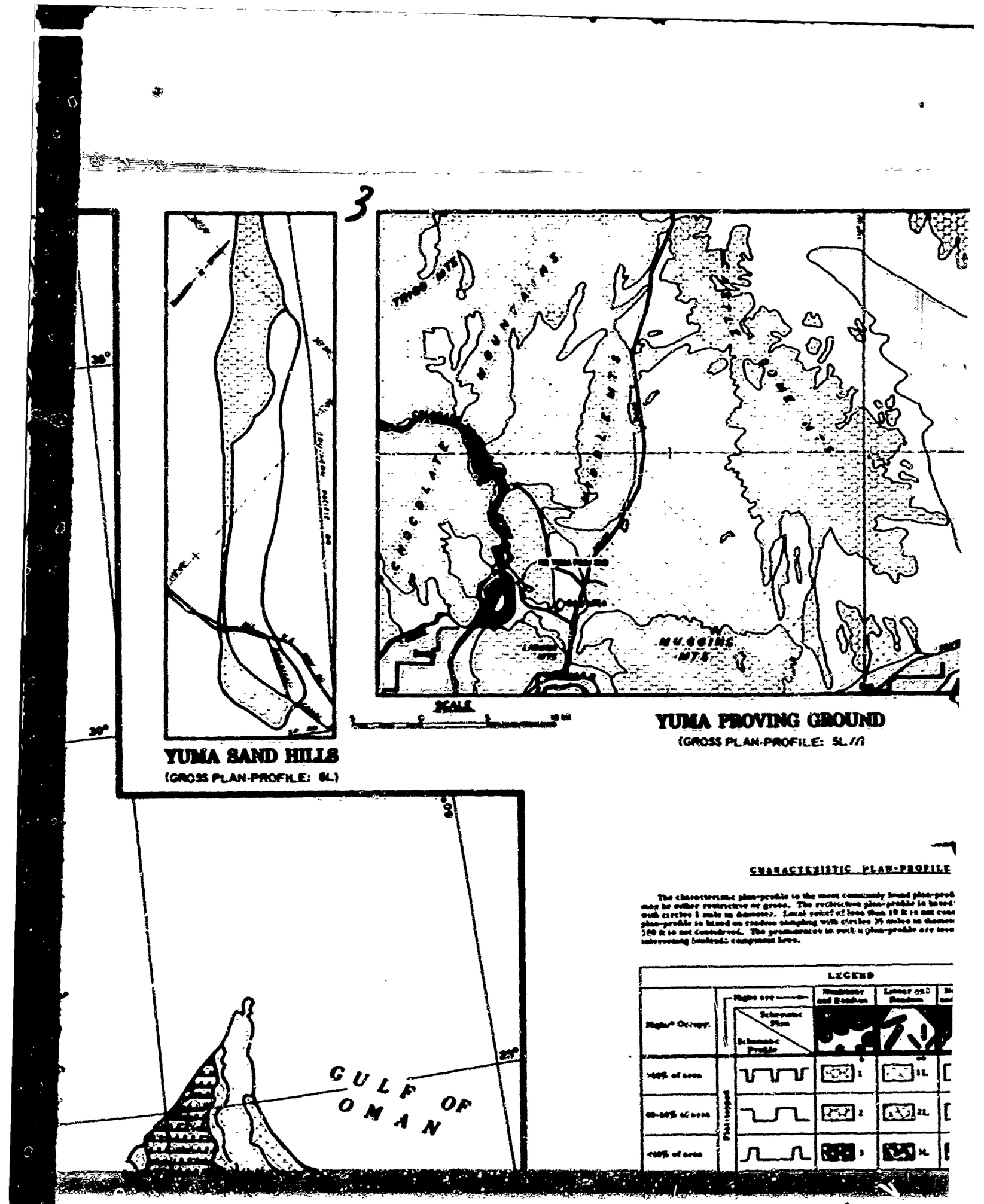
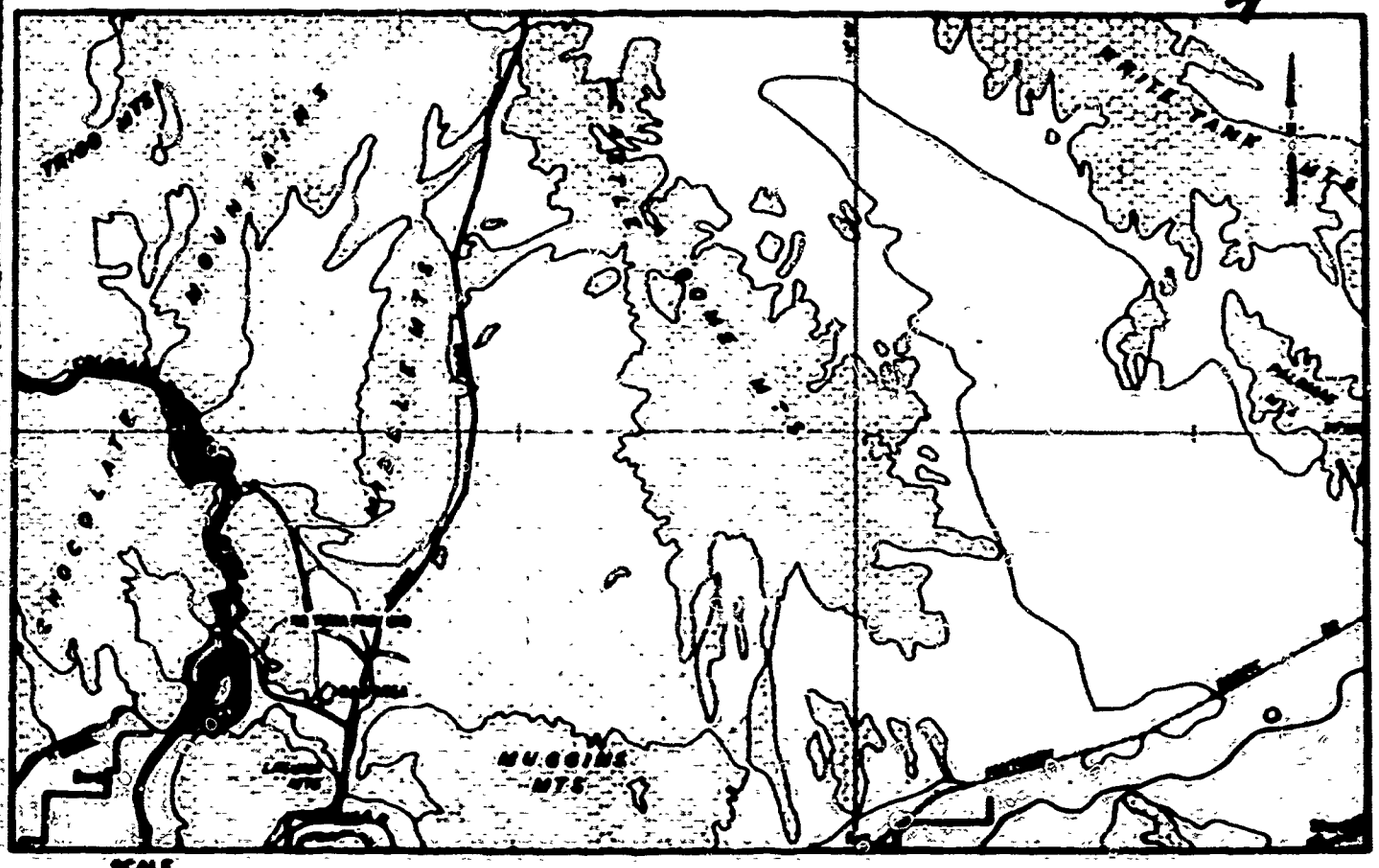
30°
25°


IRAN
PERSIAN GULF
KUWAIT
QATAR
NEUTRAL ZONE
NEUTRAL ZONE
YUMA SAND

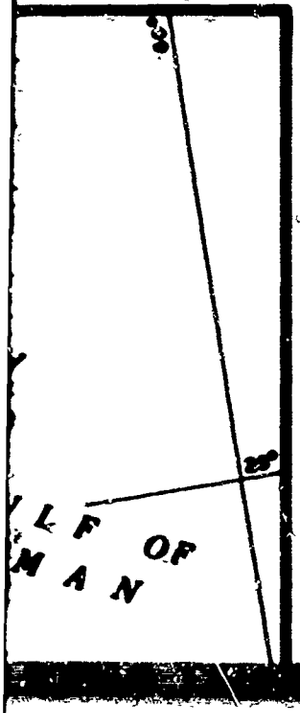

3
YUMA SAND HILLS
(GROSS PLAN-PROFILE: 6L)
YUMA PROVING GROUND
(GROSS PLAN-PROFILE: 5L)
MUGGINS MTS.
SCALE
GULF OF OMAN
CHARACTERISTIC PLAN-PROFILE
LEGEND



SCALE

YUMA PROVING GROUND

(GROSS PLAN-PROFILE: 5L//)

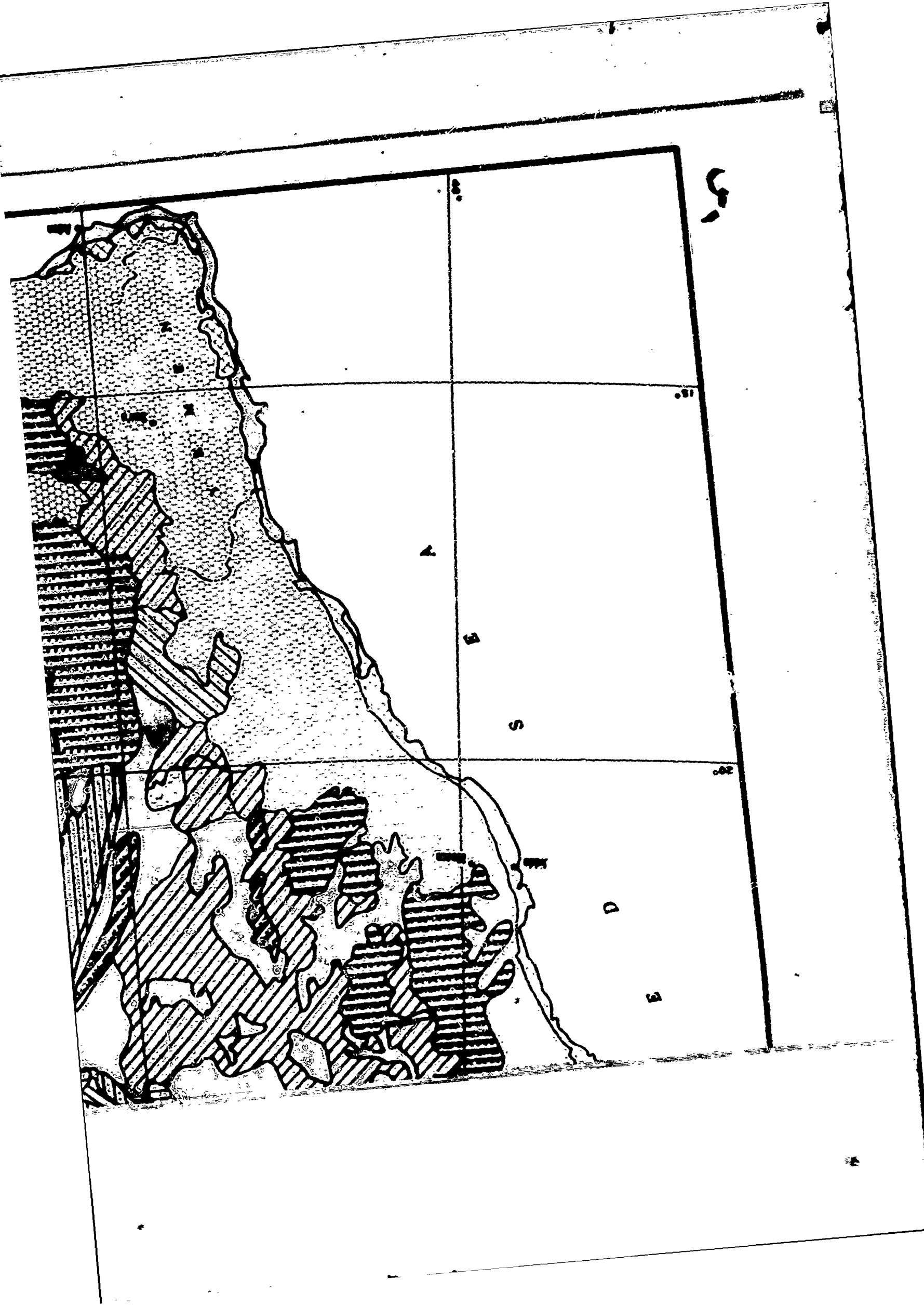


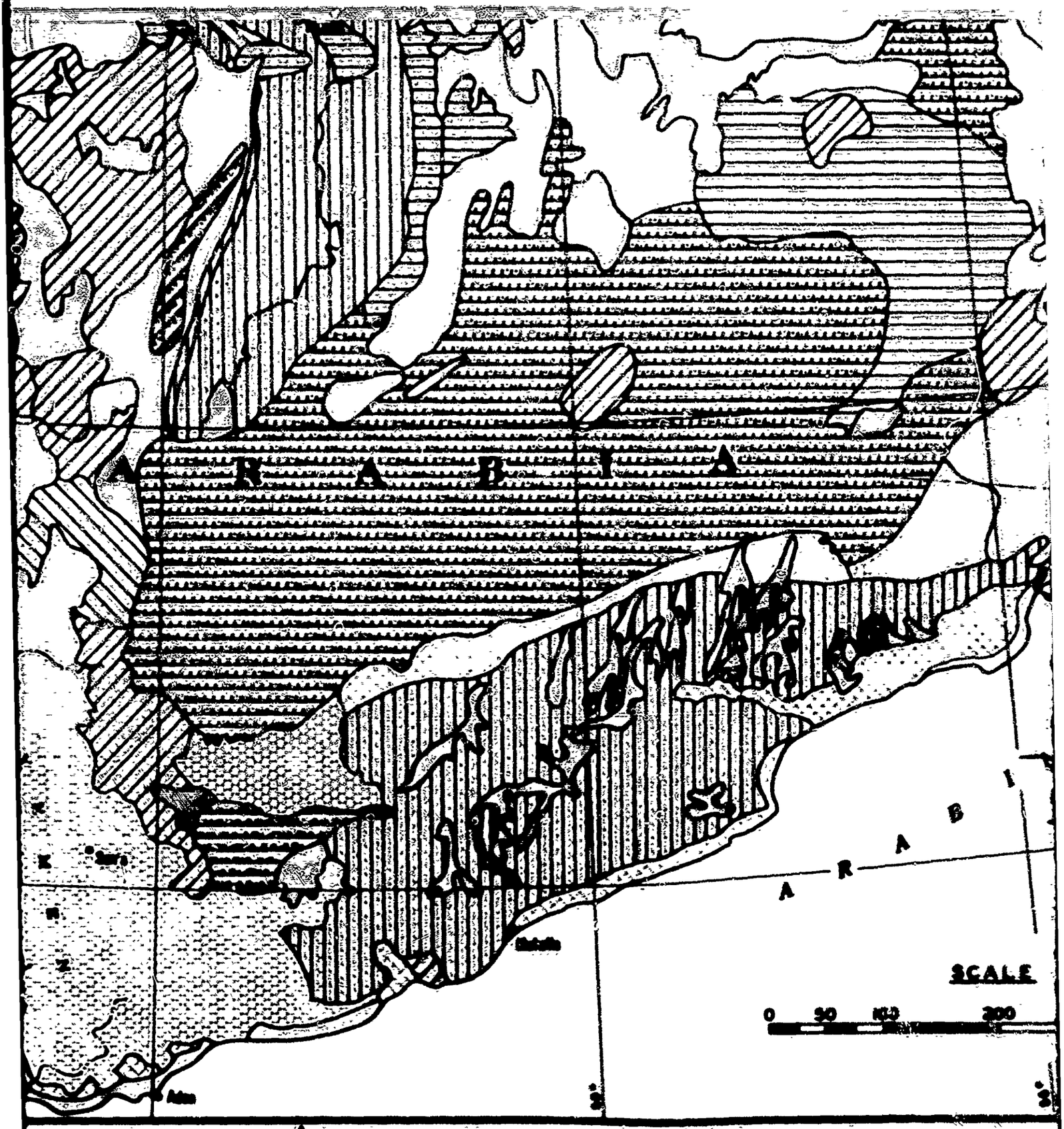
CHARACTERISTIC PLAN-PROFILE:

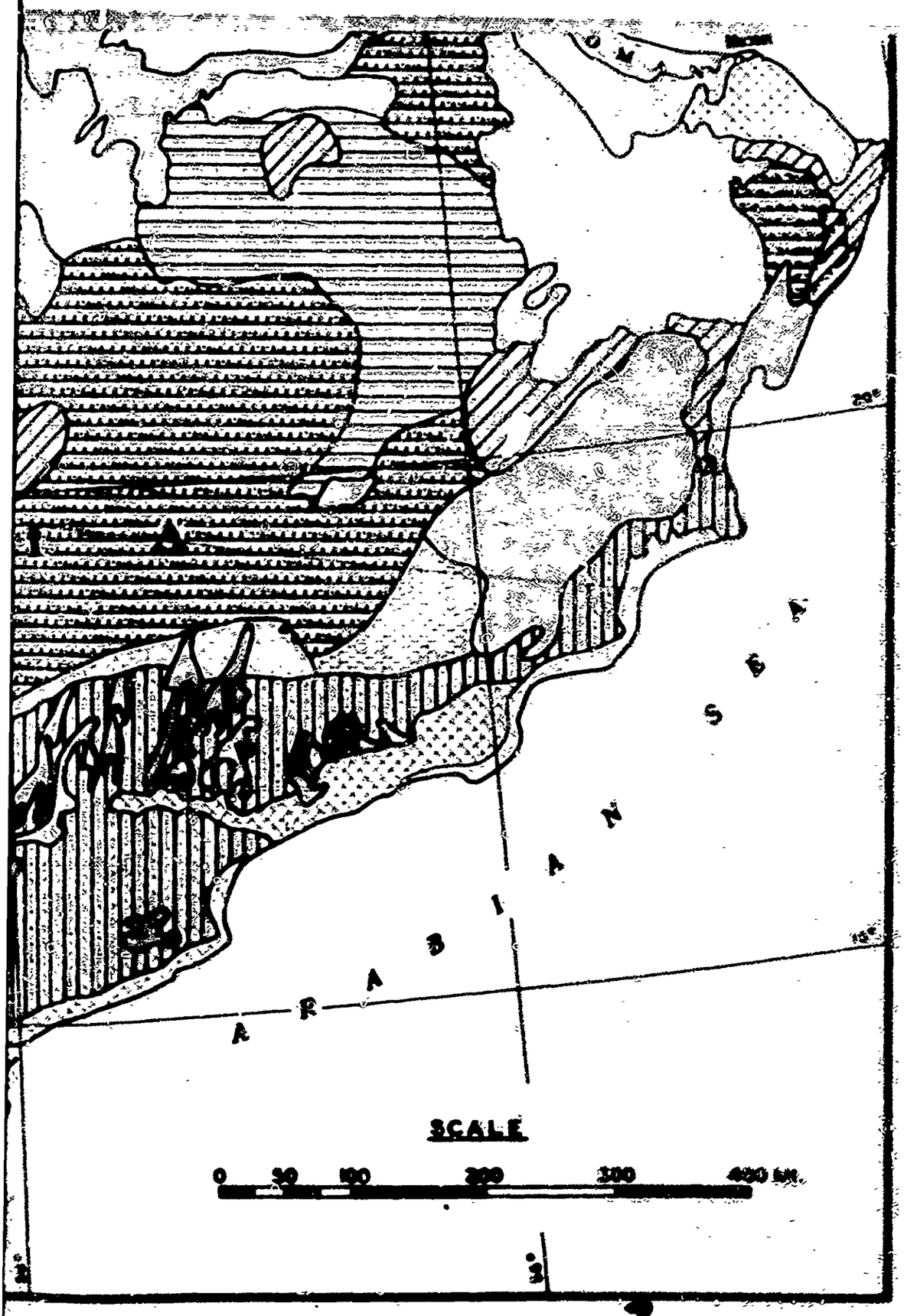
The characteristic plan-profile is the most commonly found plan-profile within a region. It may be either restrictive or gross. The restrictive plan-profile is based on random sampling with circles 1 mile in diameter. Local relief of less than 10 ft is not considered. The gross plan-profile is based on random sampling with circles 35 miles in diameter. Relief of less than 100 ft is not considered. The parameters in each plan-profile are termed component higher, the intervening lowlands component lower.

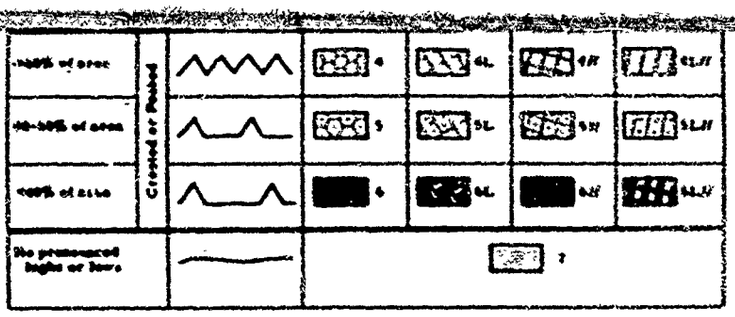
LEGEND

Higher* Occupy:	Higher are ——— / Schematic Plan / Schematic Profile	Nonlinear and Random	Linear and Random	Nonlinear and Parallel	Linear and Parallel
>60% of area	Plain-topped	1	1L	1H	1L,H
10-60% of area		2	2L	2H	2L,H
<10% of area		3	3L	3H	3L,H




ARABIA
ARABIAN
SCALE
0 50 100 200


OMAN
20°
15°
ARABIAN SEA
SCALE
0 50 100 200 300 400 km.



PLAN-PROFILE COMPLEXES

Areal Complexes: Confined to areas where two major, areally restricted plan-profiles, both of the constructive type, are mapped.

Plan-profile of the areally predominant form.
Plan-profile of the areally subordinate highs.

Plan-profile of the areally predominant highs.
Plan-profile of the areally subordinate form.

Cross-component Complexes: Confined to areas where a gross and a constructive plan-profile of either a component high or a component low are mapped.

Gross plan-profile.
Constructive plan-profile of component form.

Gross plan-profile.
Constructive plan-profile of component highs.

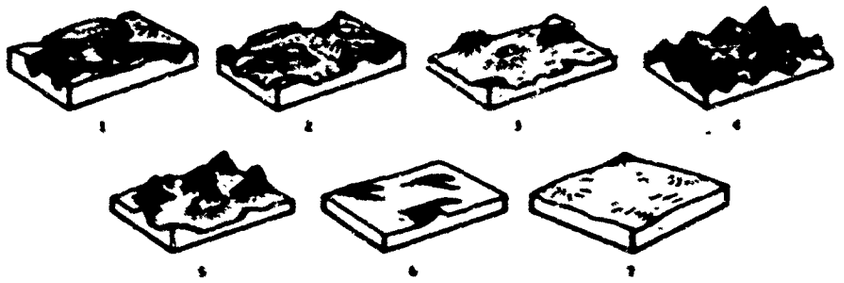
* Highs are considered to be (1) positive or erected prominences which exhibit characteristic slopes greater than 6 degrees or (2) fairly flat-topped prominences or high-level areas bounded by slopes in excess of 10 degrees.

** L indicates lengthy of highs. A high is considered to be linear when its length is greater than 3 times its width.

*** P indicates roughly parallel arrangement of highs or aligned highs.

REPRESENTATIVE PLAN-PROFILES

Each of the following block diagrams illustrates a landscape representative of a specific plan-profile type. It should be emphasized that, within the defined limits of each type, a wide variety of landscape configurations are possible.



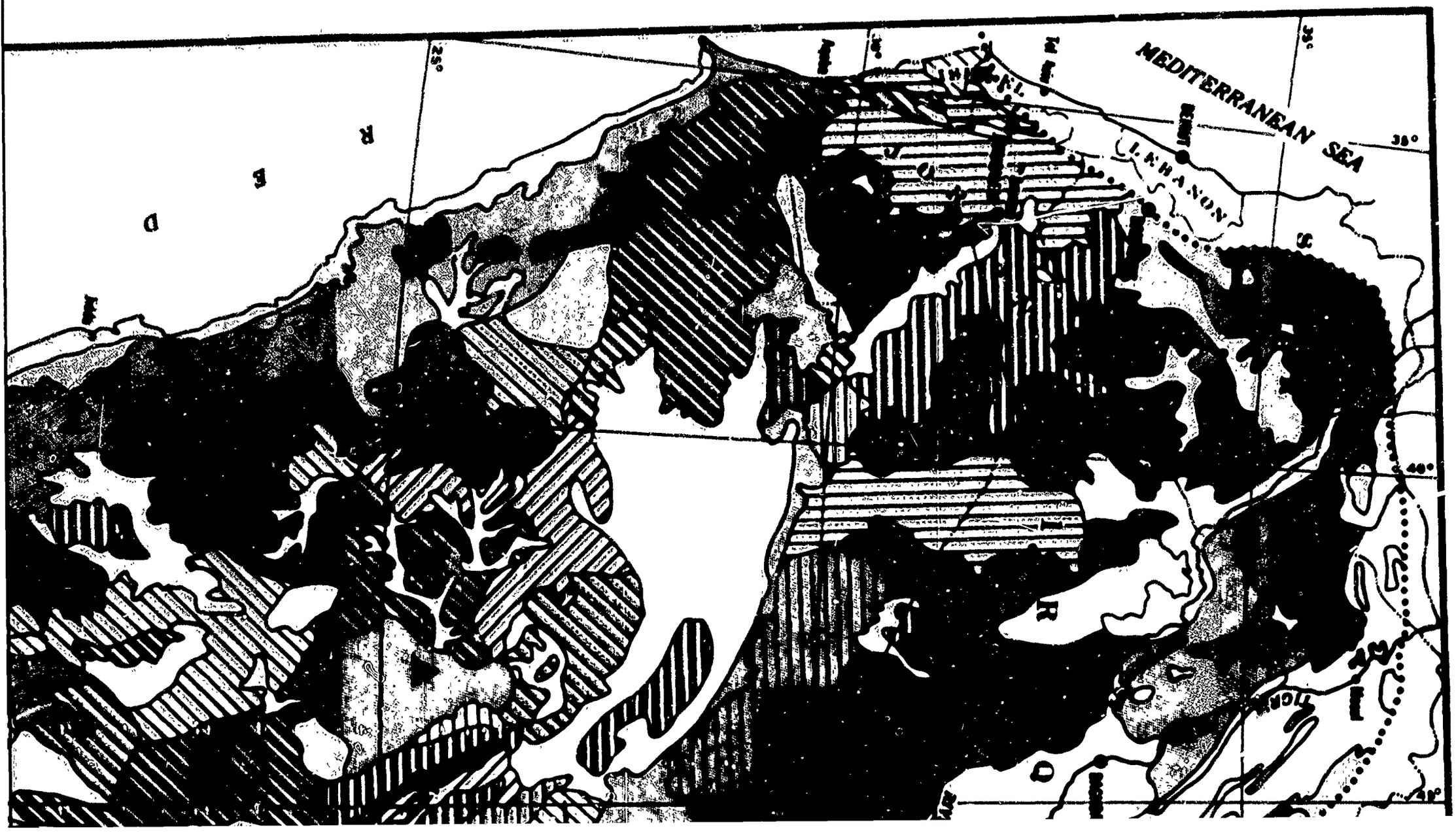
ANALOGS OF YUMA TERRAIN

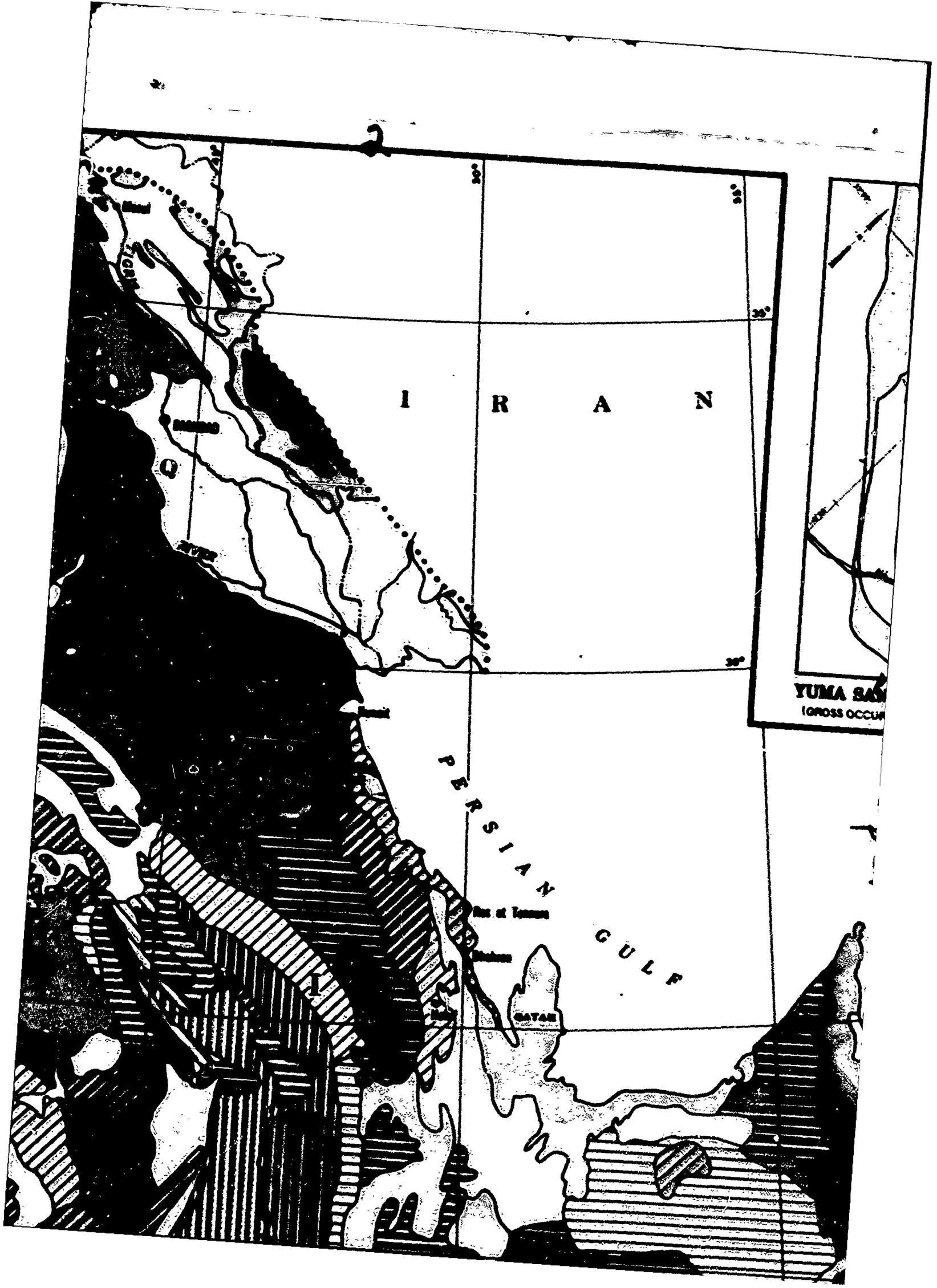
IN THE

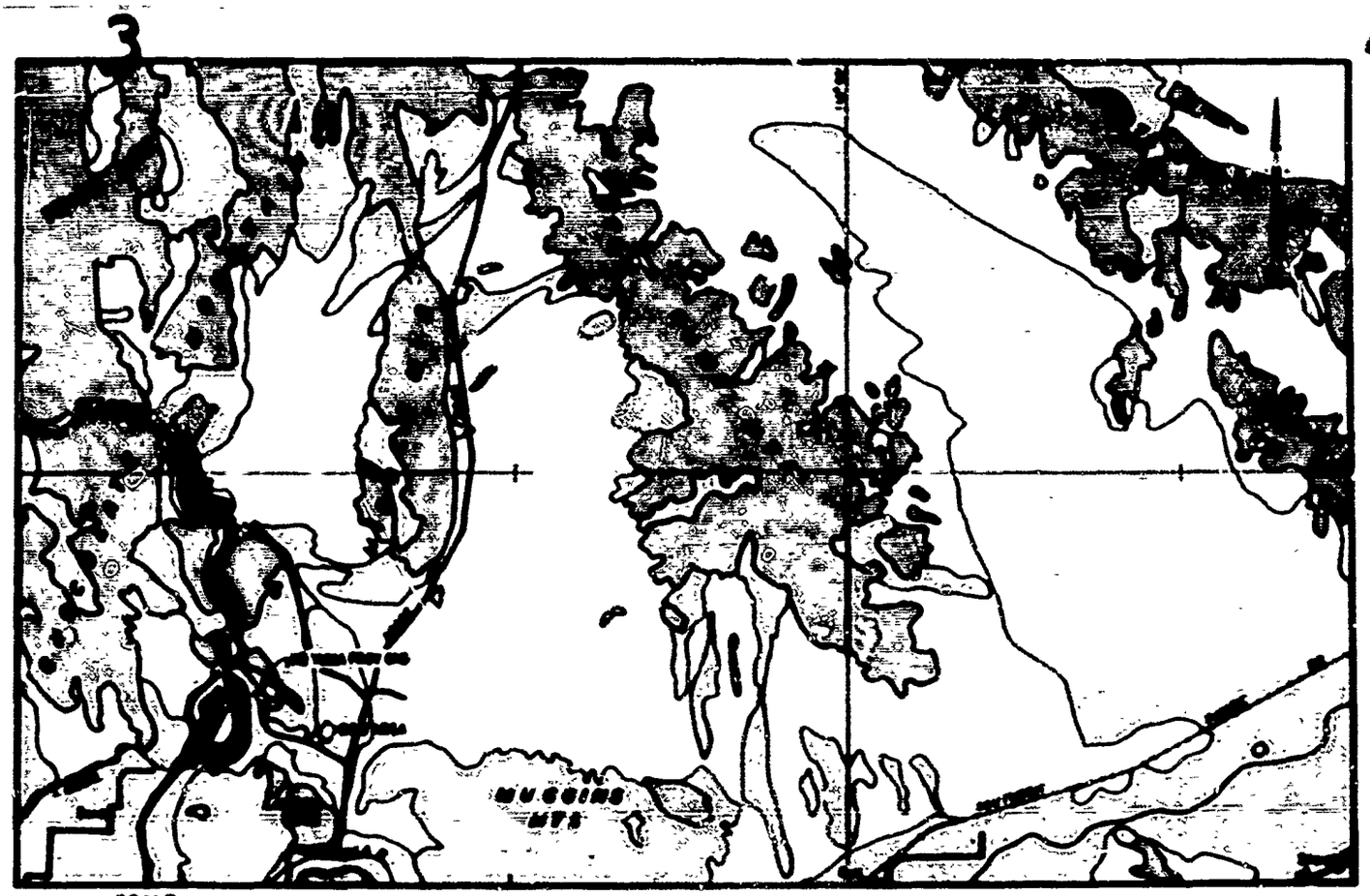
MIDDLE EAST DESERT

CHARACTERISTIC PLAN-PROFILE

PLATE 1


MEDITERRANEAN SEA
35°
38°
40°


I R A N
PERSIAN GULF
QATAR
YUMA SA
(GROSS OCCLU



SCALE

YUMA PROVING GROUND

(GROSS OCCURRENCE OF COMPONENT HIGHS: 1)

ILLS
E: 1)

OCCURRENCE OF SLOPES GREATER THAN 10 PER CENT

Occurrence may be either restrictive or gross. A restrictive occurrence does indicate a modal range of slopes greater than 10 per cent found along traverses containing the maximum number of such slopes. Relief of less than 10 ft is not considered. A gross occurrence indicates the modal distance between component highs or component lows. Relief of less than 100 ft is not considered.

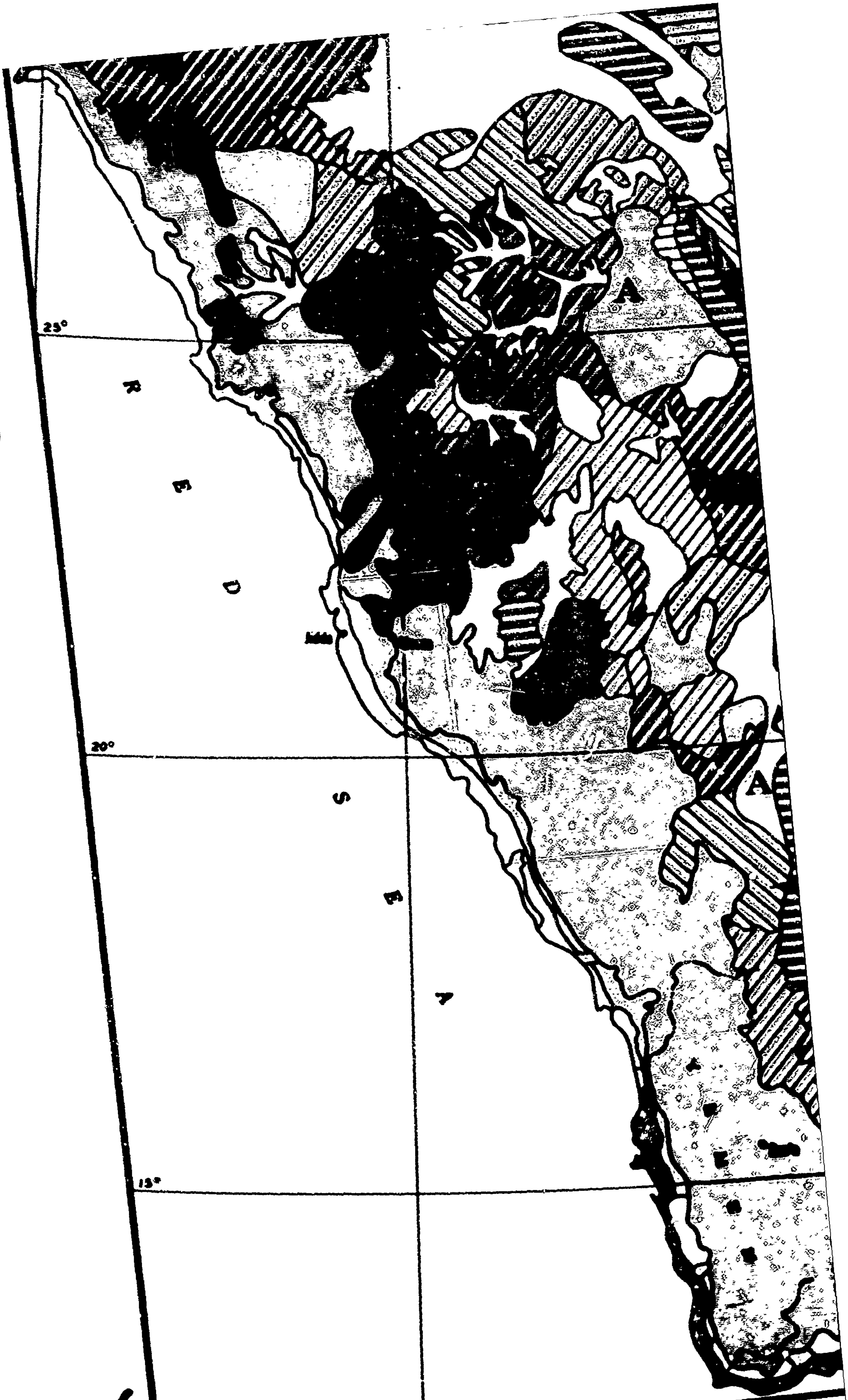
1. The number of slopes steeper than 10 per cent is less than 1 per 10 miles or so, less than 10 miles in maximum dimension, where such slopes are lacking.
2. The number of slopes steeper than 10 per cent ranges from 1 to 5 per 10 miles.
3. The number of slopes steeper than 10 per cent ranges from 5 to 20 per 10 miles.
4. The number of slopes steeper than 10 per cent ranges from 20 to 100 per 10 miles.
5. The number of slopes steeper than 10 per cent ranges from 100 to 200 per 10 miles.
6. The number of slopes steeper than 10 per cent exceeds 200 per 10 miles.

OCCURRENCE COMPLEXES: (Mapped only where plan-provide complexes are mapped.)

Areal Complexes: Confined to areas where two major, areally contrasted occurrence units, both of the restrictive type, are mapped.

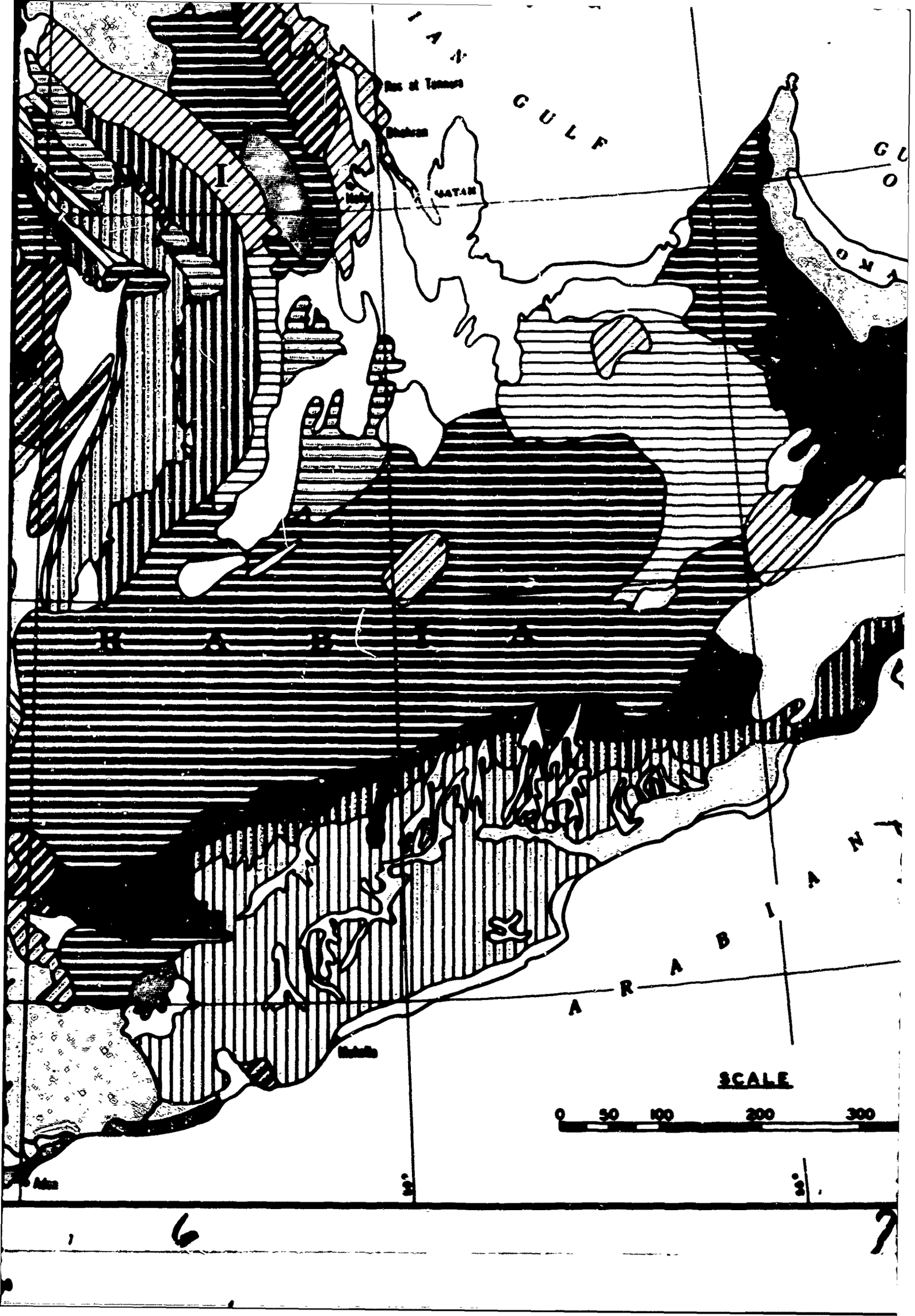
2/5 — Slope occurrence of areally predominant lows. / Slope occurrence of areally subordinate highs.

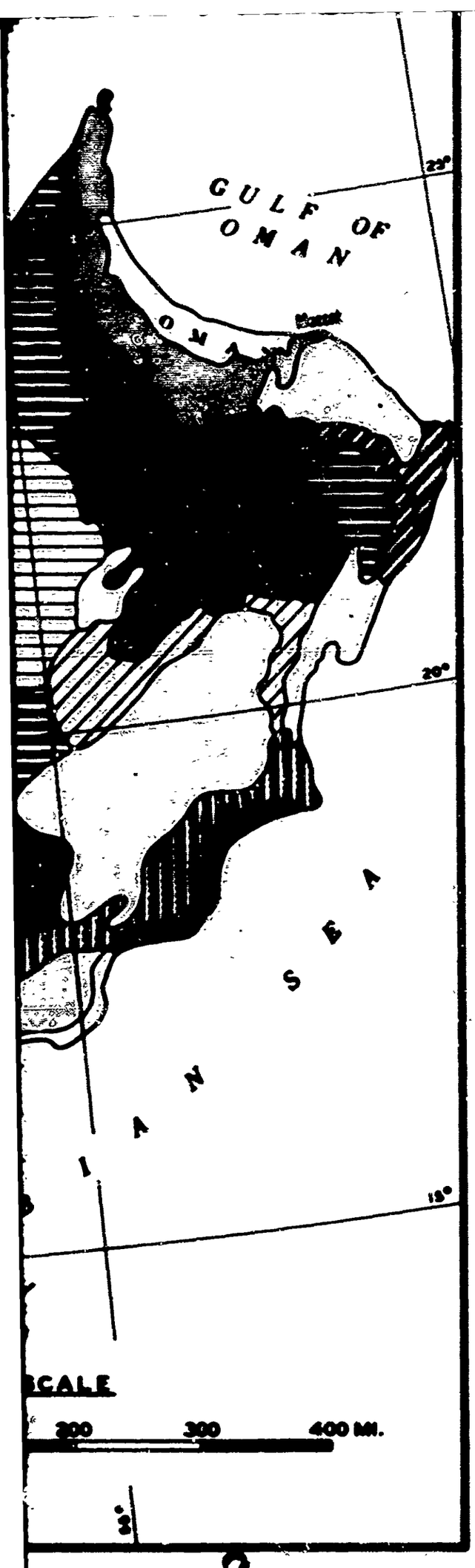
5/2 — Slope occurrence of areally predominant highs. / Slope occurrence of areally subordinate lows.


25°
R E D
Jidda
20°
S E A
15°


RSIAN GULF
Ras al Tannura
Dhahran
QATAR
A
I
A
A R A B
0 50 100

5'


GULF
QATAR
ARABIAN
SCALE
0 50 100 200 300



OCCURRENCE OF SLOPES GREATER THAN 50 PER CENT

Occurrence may be either restrictive or gross. A restrictive occurrence class indicates a modal range of slopes greater than 50 per cent found along traverses containing the maximum number of such slopes. Relief of less than 10 ft is not considered. A gross occurrence indicates the modal distance between component highs or component lows. Relief of less than 100 ft is not considered.

1. The number of slopes steeper than 50 per cent is less than 1 per 10 miles or in areas, less than 10 miles in maximum dimensions, where such slopes are lacking.
2. The number of slopes steeper than 50 per cent ranges from 1 to 5 per 10 miles.
3. The number of slopes steeper than 50 per cent ranges from 5 to 20 per 10 miles.
4. The number of slopes steeper than 50 per cent ranges from 20 to 100 per 10 miles.
5. The number of slopes steeper than 50 per cent ranges from 100 to 200 per 10 miles.
6. The number of slopes steeper than 50 per cent exceeds 200 per 10 miles.

OCCURRENCE COMPLEXES: (Mapped only where plan-profile complexes are mapped.)

Areal Complexes. Confined to areas where two major, areally restricted occurrence units, both of the restrictive type, are mapped.

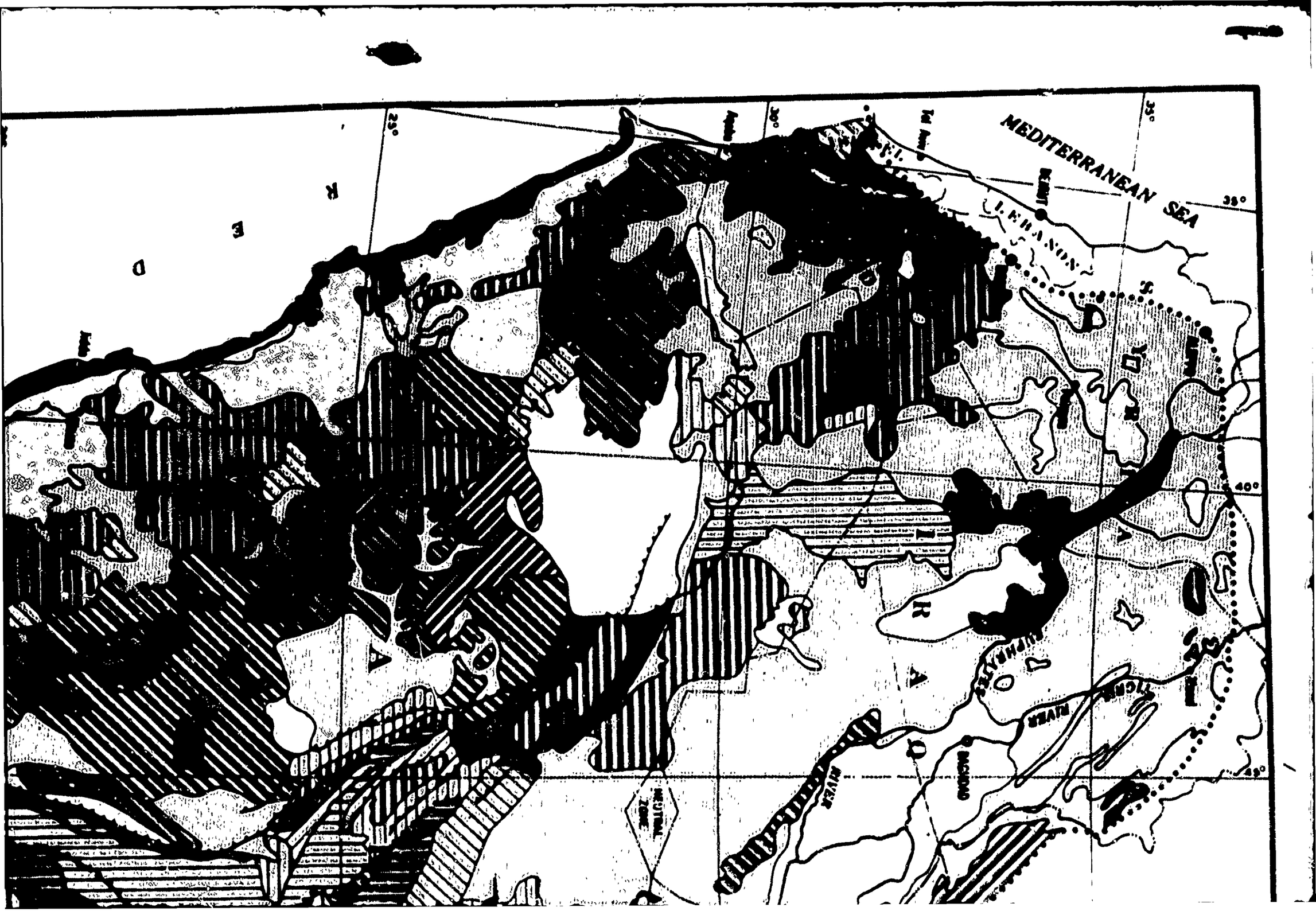
- 1/3 — Slope occurrence of areally predominant lows. Slope occurrence of areally subordinate highs.
- 2/3 — Slope occurrence of areally predominant highs. Slope occurrence of areally subordinate lows.

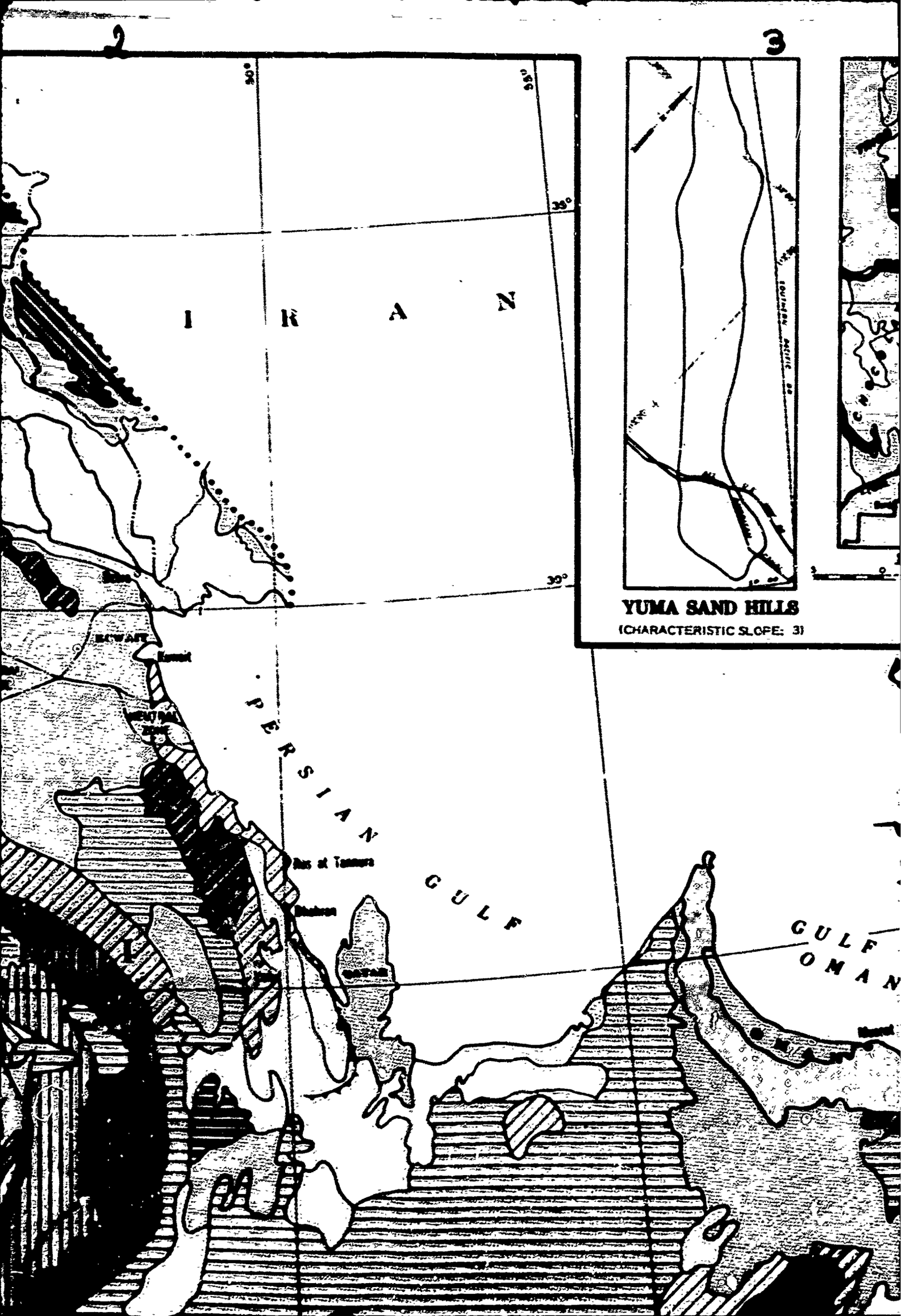
Gross-component Complexes: Mapped only where gross-component plan-profile complexes are mapped.

- Gross occurrence of component highs. Restrictive occurrence within component lows.
- Gross occurrence of component lows. Restrictive occurrence within component highs.

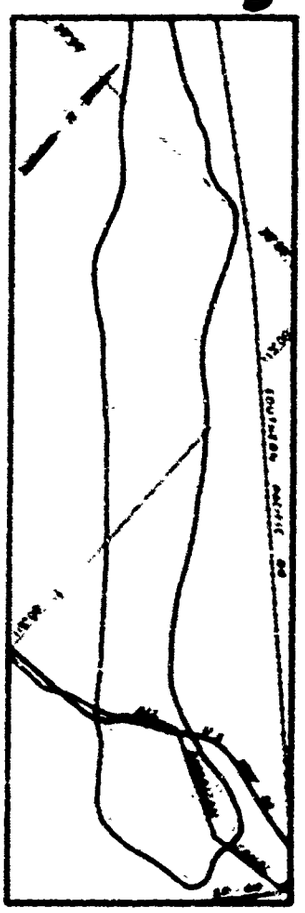
ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

OCCURRENCE OF SLOPES GREATER THAN 50 PERCE


MEDITERRANEAN SEA
LEBANON
SYRIA
IRAQ
SAUDI ARABIA
KUWAIT
NEUTRAL ZONE
EUPHRATES
TIGRIS
RIVER
RIVER
BAGHDAD
33°
36°
39°
42°


2
3
IRAN
PERSIAN GULF
GULF OF OMAN
YUMA SAND HILLS
(CHARACTERISTIC SLOPE: 3)

3

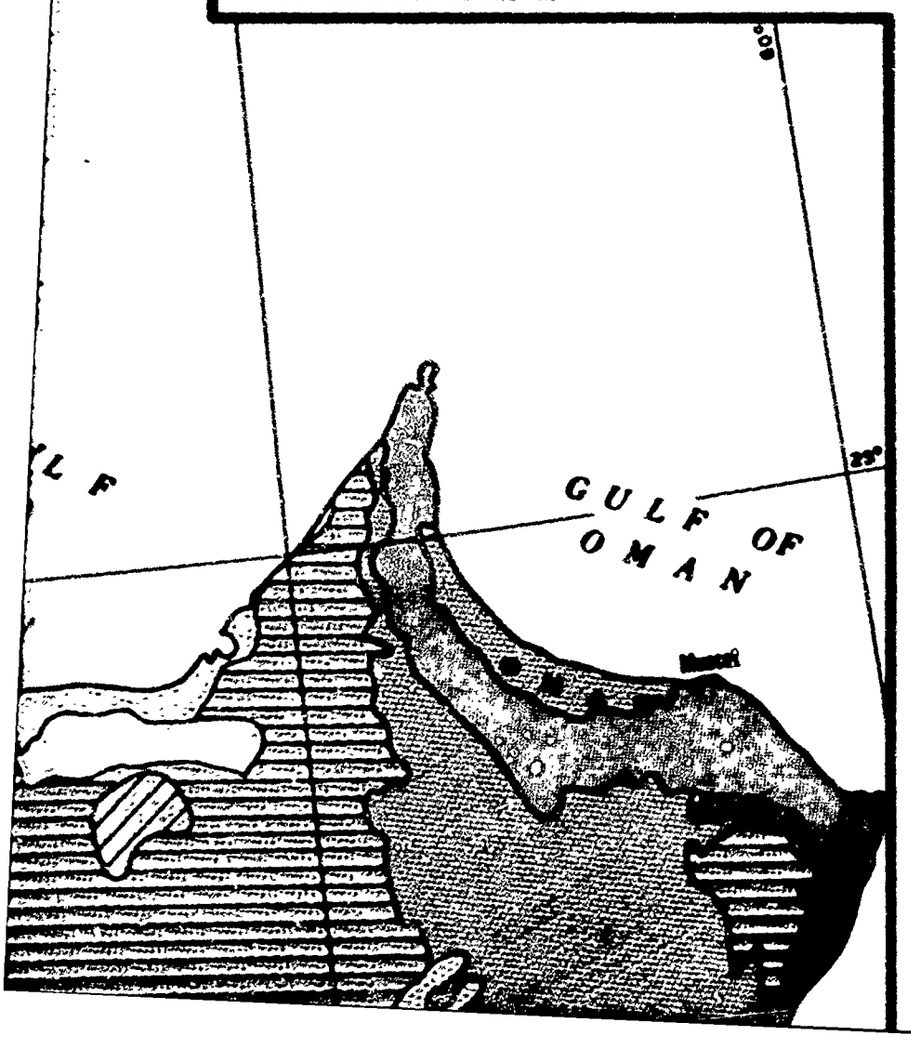


YUMA SAND HILLS

(CHARACTERISTIC SLOPE: 3)

YUMA PROVING GROUND

(CHARACTERISTIC SLOPE WITHIN COMPONENT HIGH



CHARACTERISTIC SLOPE

Slope is defined as a surface's deviation from the horizontal. Characteristic range of slopes which predominates or is most noteworthy in distinctive landscape arrangement mapped with a 10-ft contour interval.

Flat: Characteristic slope between 0 and 0 - 1.9%).

1a: Between 0 and 1/2 degree (0%)

1b: Between 1/2 and 2 degrees (1%)

2: Gentle: Characteristic slope between 2 1.9 - 10%).

3: Moderate: Characteristic slope between 10 - 25%)

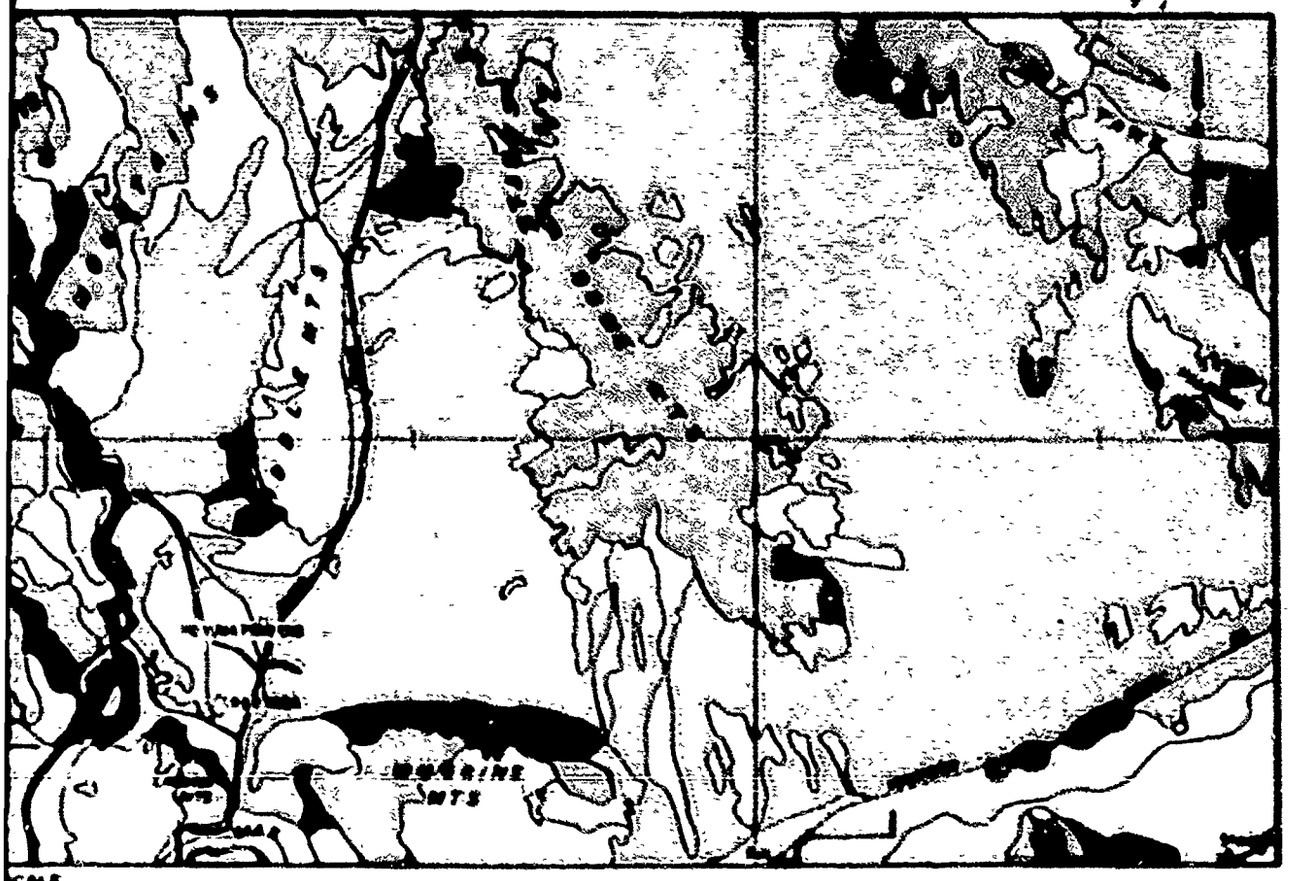
4: Rolling: Characteristic slope between 25 - 50%).

5: Steep: Characteristic slope between 50 - 100%).

6: Precipitous: Characteristic slope greater than 100%).

SLOPE COMPLEXES: (Mapped only where plain Areal Complexes: Continued to areas of slope types are mapped.

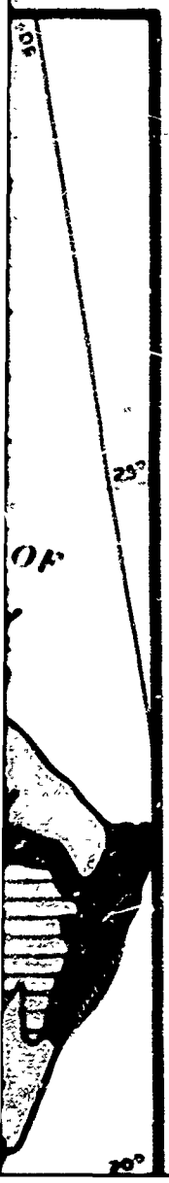
Characteristic slope of actually ge



SCALE

YUMA PROVING GROUND

CHARACTERISTIC SLOPE WITHIN COMPONENT HIGHS (%)



CHARACTERISTIC SLOPE

Slope is defined as a surface or method of designation in terms of its deviation from the horizontal. Characteristic slope is defined as a narrow range of slopes which predominates or is most common within a region possessing a distinctive spacing, arrangement, or pattern of landform (areal mapped with a 10 m contour interval)

Flat Characteristic slope between 0 and 2 degrees (approx. 0 - 3%)

Between 2 and 3 1/2 degrees (approx. 4 - 7%)

Between 3 1/2 and 7 degrees (approx. 8 - 14%)

Gentle Characteristic slope between 7 and 9 degrees (approx. 15 - 19%)

Moderate Characteristic slope between 9 and 16 degrees (approx. 20 - 29%)

Steep Characteristic slope between 16 and 25.5 degrees (approx. 30 - 49%)

Very Steep Characteristic slope between 25.5 and 45 degrees (approx. 50 - 100%)

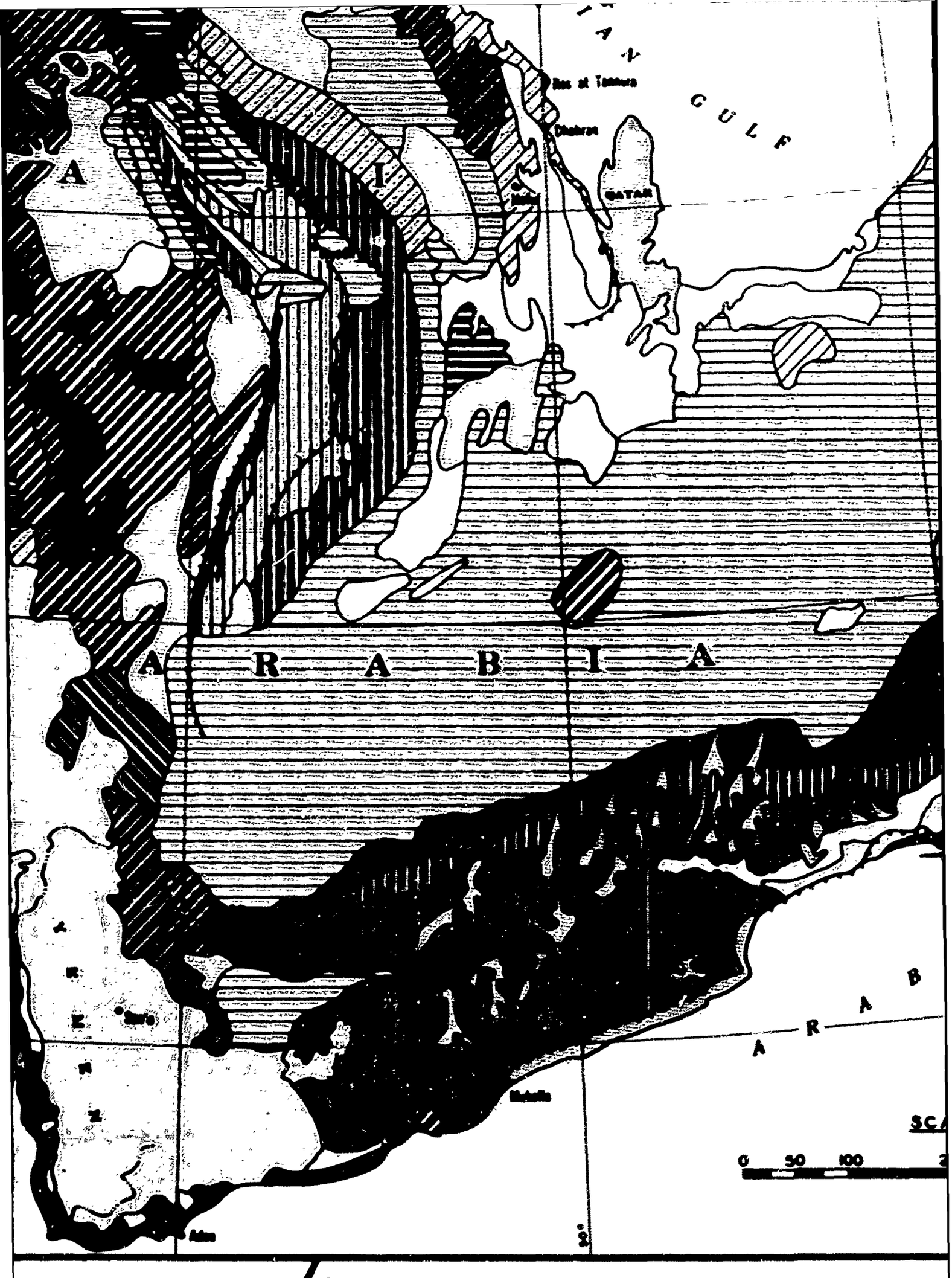
Precipitous Characteristic slope greater than 45 degrees (greater than 100%)

SLOPE COMPLEXES (Mapped only where plus gentle complexes are mapped)
Areal Complexes Confined to areas where two major areally predominant slope types are mapped

Characteristic slope of areally predominant type
Characteristic slope of areally subordinate type

Characteristic slope of areally predominant type
Characteristic slope of areally subordinate type


A
E
S
A
R
E
D
25°
20°
15°


GULF
Ras al Tannura
Dhahran
QATAR
A R A B I A
A R A B
0 50 100

CHARACTERISTIC SLOPE

Slope is defined as a surface considered or designated in terms of its deviation from the horizontal. Characteristic slope is defined as a narrow range of slopes which predominates or is most common within a region possessing a distinctive spacing, arrangement, or pattern of contour lines) mapped with a 15-ft contour interval.

Flat: Characteristic slope between 0 and 2 degrees (approx. 0 - 3.5%).

3a — Between 0 and 1/2 degree (approx. 0 - 1%).

3b — Between 1/2 and 2 degrees (approx. 1 - 3.5%).

2 — Gentle: Characteristic slope between 2 and 6 degrees (approx. 3.5 - 10%).

1 — Moderate: Characteristic slope between 6 and 16 degrees (approx. 10 - 29%).

4 — Inclination: Characteristic slope between 16 and 26.5 degrees (approx. 29 - 50%).

5 — Steep: Characteristic slope between 26.5 and 45 degrees (approx. 50 - 100%).

6 — Precipitous: Characteristic slope greater than 45 degrees (greater than 100%).

SLOPE COMPLEXES: (Mapped only where plan-geodic complexes are mapped)
Areal Complexes: Confined to areas where two (rarely, usually restricted slope types are mapped.

2/4 — Characteristic slope of areally predominant form.
Characteristic slope of areally subordinate height.

4/1 — Characteristic slope of areally predominant height.
Characteristic slope of areally subordinate form.

Areal-component Complexes: Mapped only where areal-component plan-geodic complexes are mapped. The symbols in the complex are arranged vertically or horizontally depending on the plan-geodic.

1/3a — Characteristic slope within component height.*
Characteristic slope within component form.

1/2 — Characteristic slope within component area.*
Characteristic slope within component height.

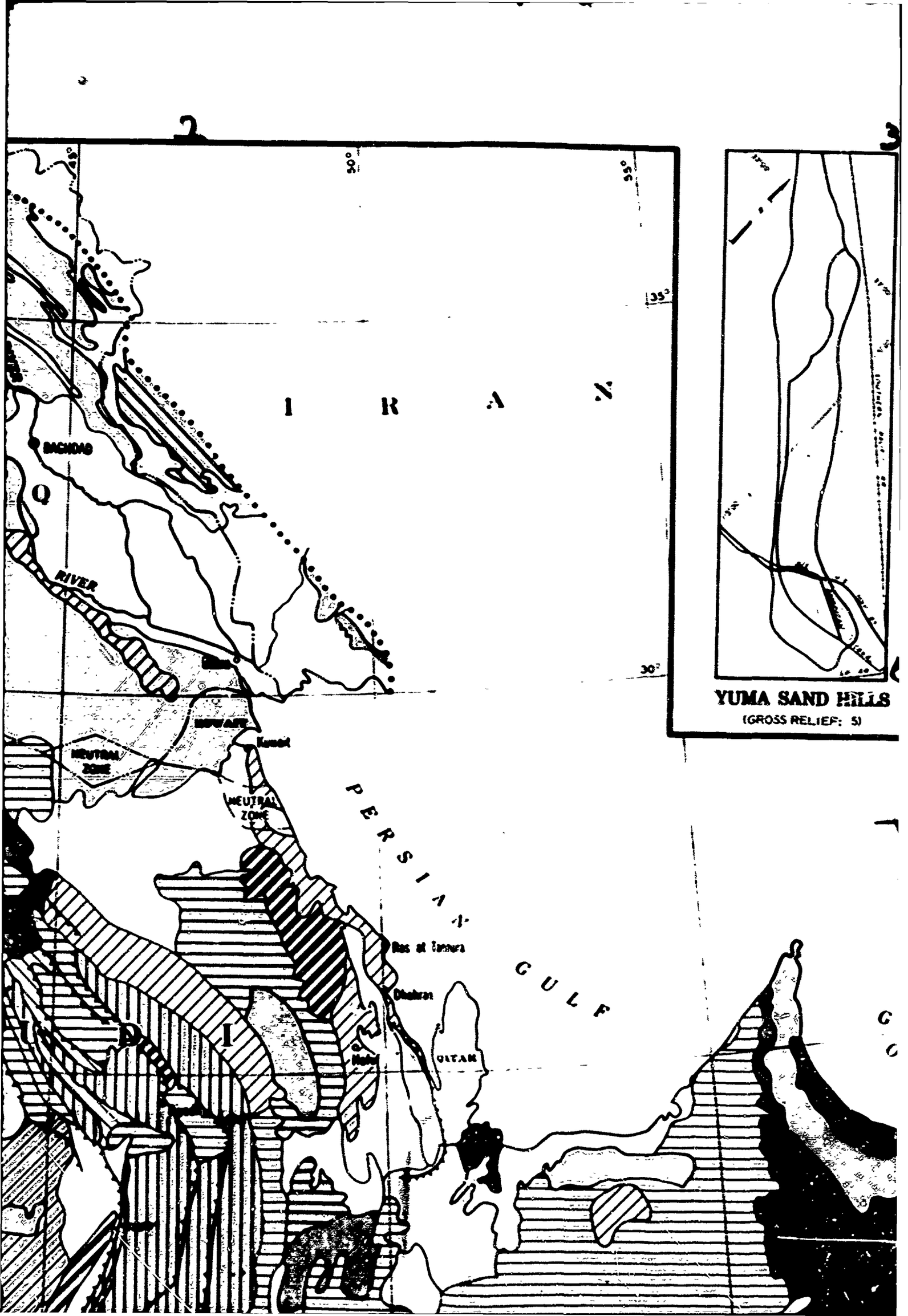
Important Scarps: An important scarp is defined as a more or less continuous precipitous slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped. Scarp height is indicated where known.

* In cases where the areal plan-geodic is flat-topped or flat-bottomed the characteristic slope is considered to be the modal slope of the bounding terrain.

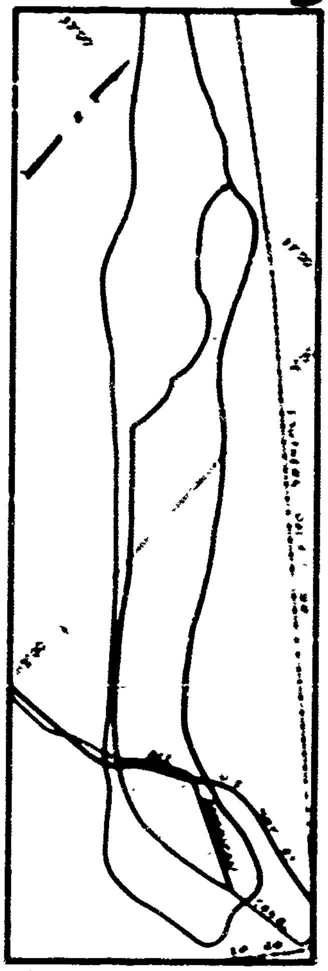
ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

CHARACTERISTIC SLOPE

MEDITERRANEAN SEA
BEIRUT
DAMASCUS
Tel Aviv
Amman
BAGHDAD
TIGRIS RIVER
EUPHRATES RIVER
RIVER
I R A Q
S A
35°
33°
30°
25°


IRAN
PERSIAN GULF
BAGHDAD
IRAQ
RIVER
NEUTRAL ZONE
NEUTRAL ZONE
Kuwait
Ras al Tannura
Dhahran
Hofuf
QATAR
YUMA SAND HILLS
(GROSS RELIEF: 5)

3

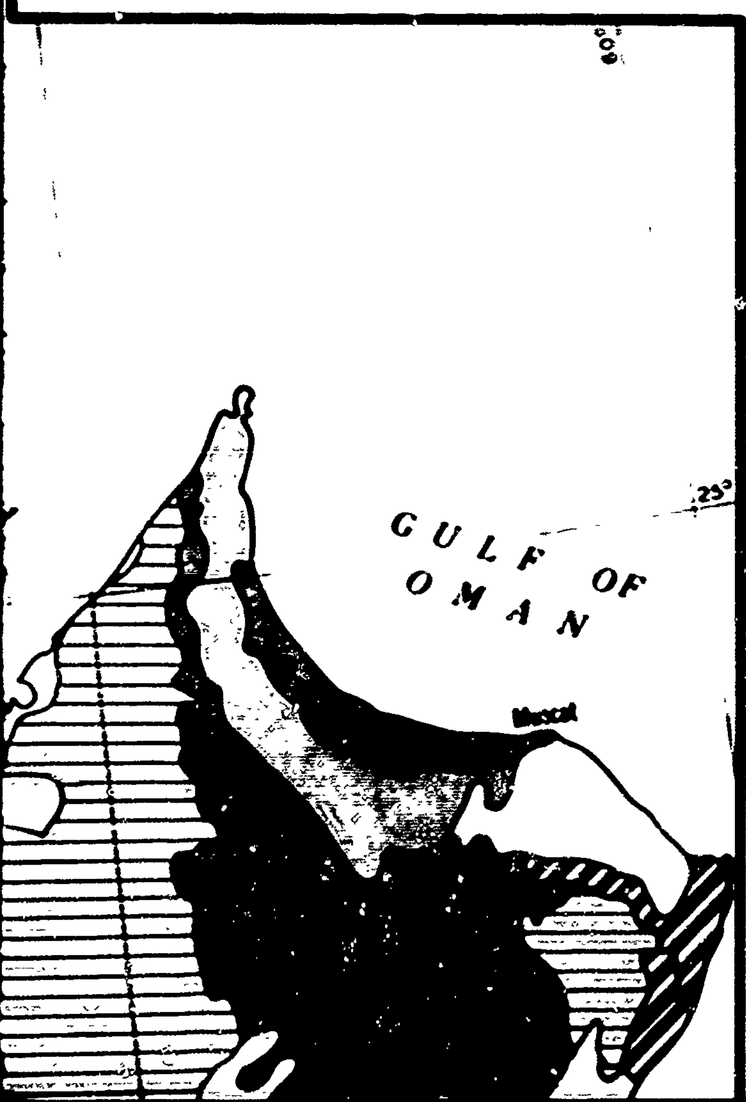


YUMA SAND HILLS

(GROSS RELIEF: 5)

YUMA PROVING GROUND

(GROSS RELIEF OF COMPONENT HIGHS: 7)



CHARACTERISTIC RELIEF

[illegible]

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

[illegible]

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

[illegible]

YUMA PROVING GROUND

(GROSS RELIEF OF COMPONENT HIGHS: 7)

CHARACTERISTIC RELIEF

[illegible]

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

[illegible]

1. Characteristic relief between [illegible] feet
2. Characteristic relief between [illegible] feet
3. Characteristic relief > [illegible] feet

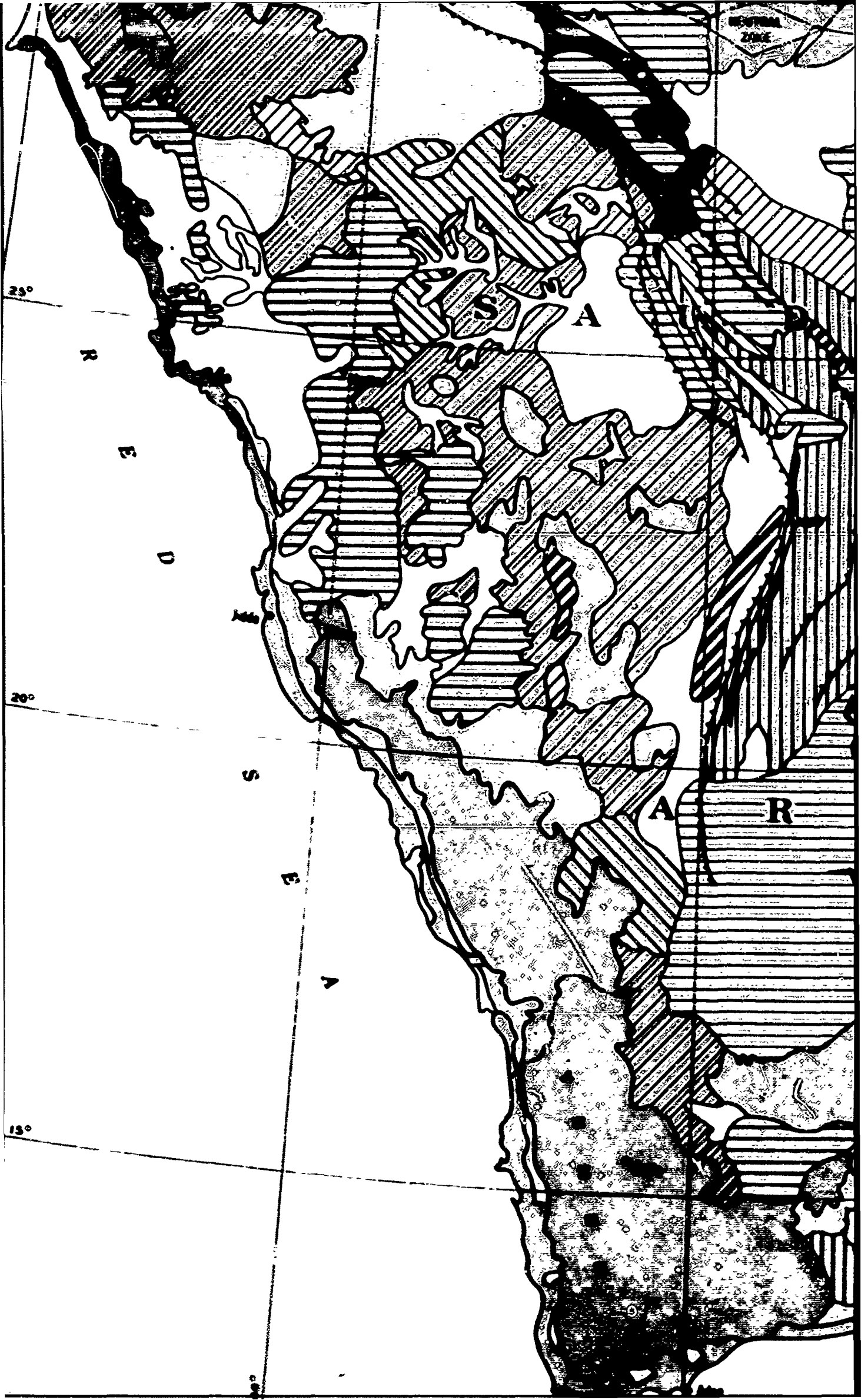
II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

[illegible]

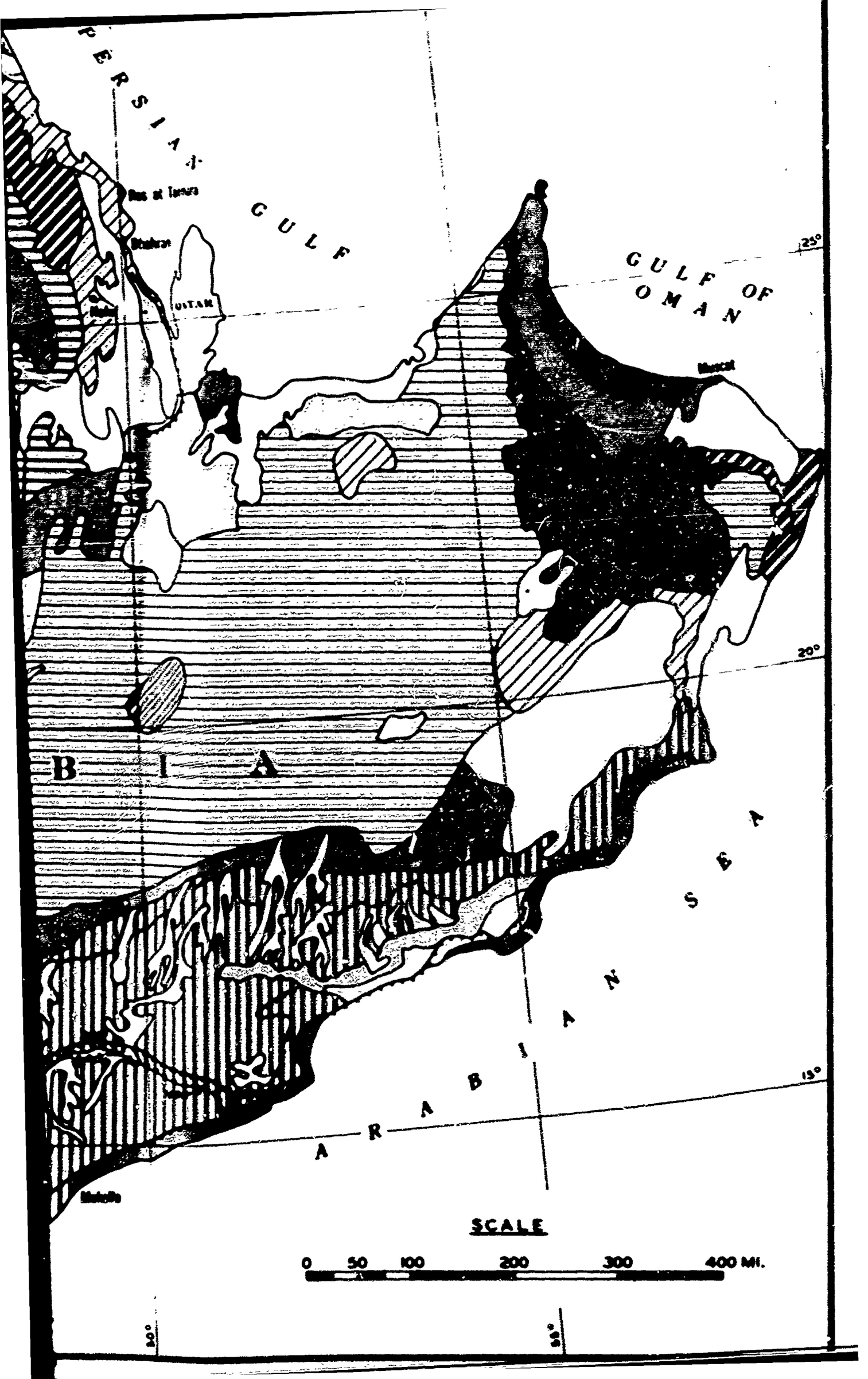
4. Characteristic relief between [illegible] feet
5. Characteristic relief between [illegible] feet
6. Characteristic relief between [illegible] feet
7. Characteristic relief greater than [illegible] feet

RELIEF COMPLEXES: [illegible]

[illegible]


25°
20°
15°
RED SEA
ARABIA


PERSIAN GULF
NEUTRAL ZONE
Ras al Tannura
Dhahran
QATAR
I
R A B I A
ARABIAN
SCALE
0 50 100 200 300


PERSIAN GULF
Ras al Hamra
Bushire
GULF OF OMAN
Muscat
25°
20°
15°
B I A
ARABIAN SEA
Mukalla
SCALE
0 50 100 200 300 400 MI.
50°
55°

CHARACTERISTIC RELIEF

Characteristic relief may be either restrictive or gross. Restrictive relief is based on modal classes of stream depth, elevation differences per unit area, or prominence height. This is further defined under type I and type II relief, below. Gross relief indicates the modal height of component highs or the modal depth of component lows.

I. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS LESS THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the modal vertical distance from divide or crest to the immediately adjacent low line, or in areas where drainage lines are poorly developed or lacking,* from summit to adjacent low.

1 Characteristic relief between 0 and 10 feet

2 Characteristic relief between 10 and 50 feet

3 Characteristic relief > 50 feet

II. RELIEF IN AREAS WHERE THE CHARACTERISTIC SLOPE IS GREATER THAN 6 DEGREES (APPROX. 10 PER CENT)

Relief is defined as the modal maximum difference in elevation per square mile, or in areas where drainage lines are poorly developed or lacking,* from summit to adjacent low.

* Usually restricted to sand dune areas; maximum height of dunes is [illegible] where known.

4 Characteristic relief between 0 and 100 feet

5 Characteristic relief between 100 and 500 feet

6 Characteristic relief between 500 and 1,000 feet

7 Characteristic relief greater than 1,000 feet

RELIEF COMPLEXES (Mapped only where [illegible] complexes are mapped.)

Areal Complexes. Confined to areas where two major areally restricted relief units, both of the restrictive type, are mapped.

1/4 Relief of areally predominant lows; Relief of areally subordinate highs

4/1 Relief of areally predominant highs; Relief of areally subordinate lows

Gross-component Complexes. (Mapped only where gross component [illegible] complexes are mapped.)

4/1 Gross relief of component highs; Restrictive relief within component lows

4/1 Gross relief of component lows; Restrictive relief within component highs

Important Scarps. A scarp is defined as a more or less continuous [illegible] slope exhibiting more than 100 feet of relief. Only the better known scarps which extend for considerable distances have been mapped. Scarp height is indicated where known.

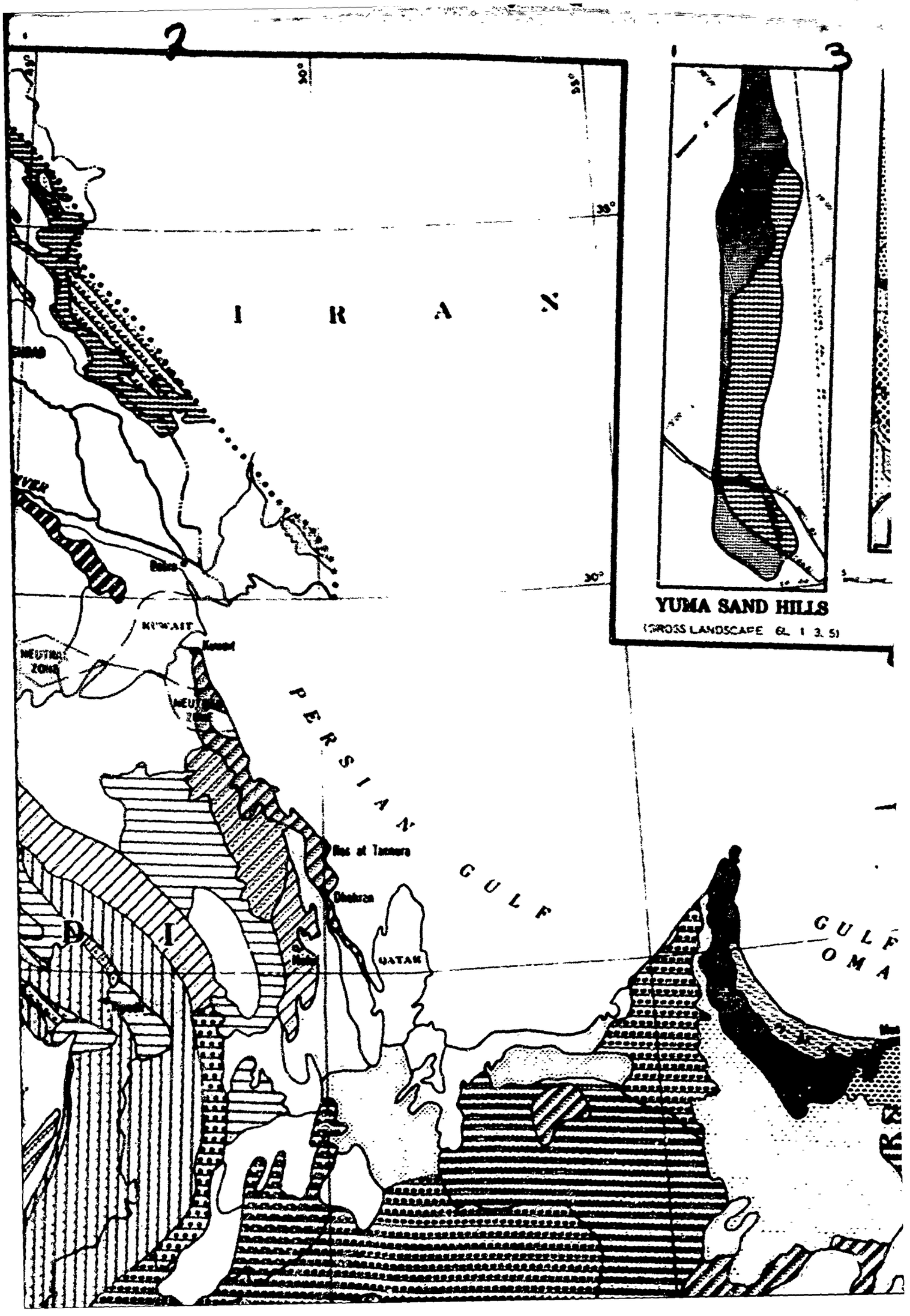
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

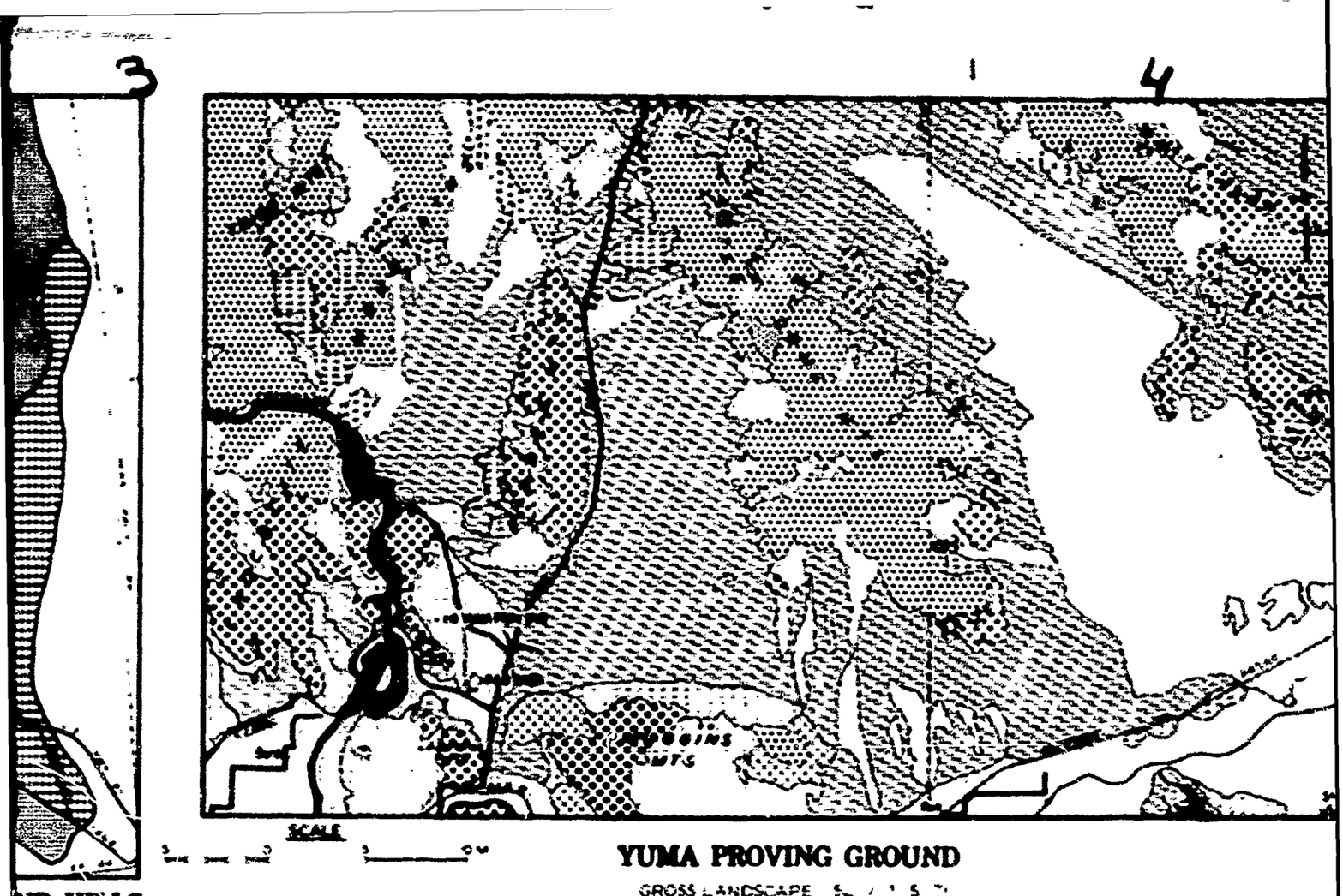
CHARACTERISTIC RELIEF

8

PLATE 4


TIGRIS RIVER
EUPHRATES
MEDITERRANEAN SEA
D
E
R

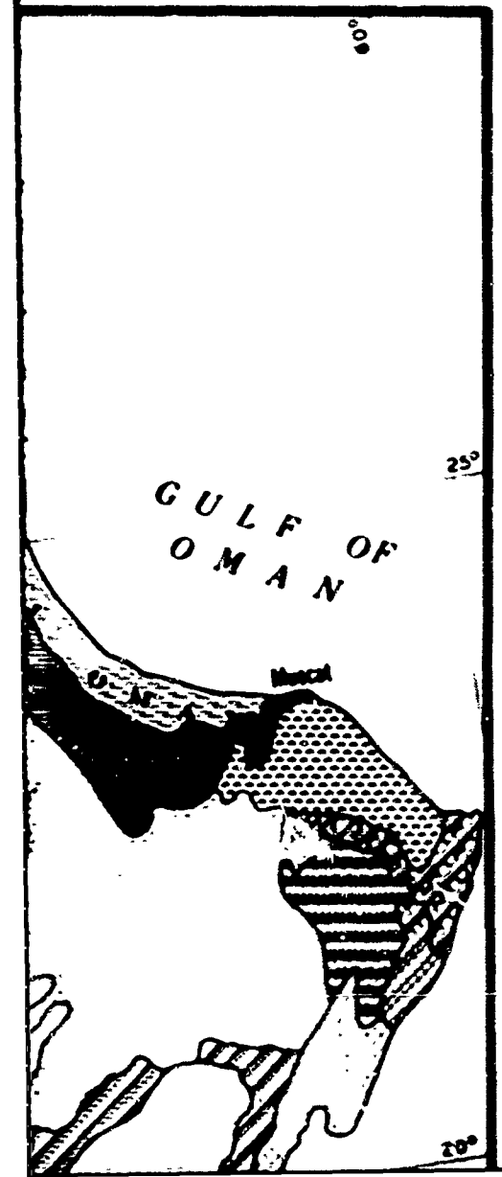

2
3
I R A N
KUWAIT
NEUTRAL ZONE
PERSIAN GULF
QATAR
YUMA SAND HILLS
(CROSS LANDSCAPE GL 1 3, 5)

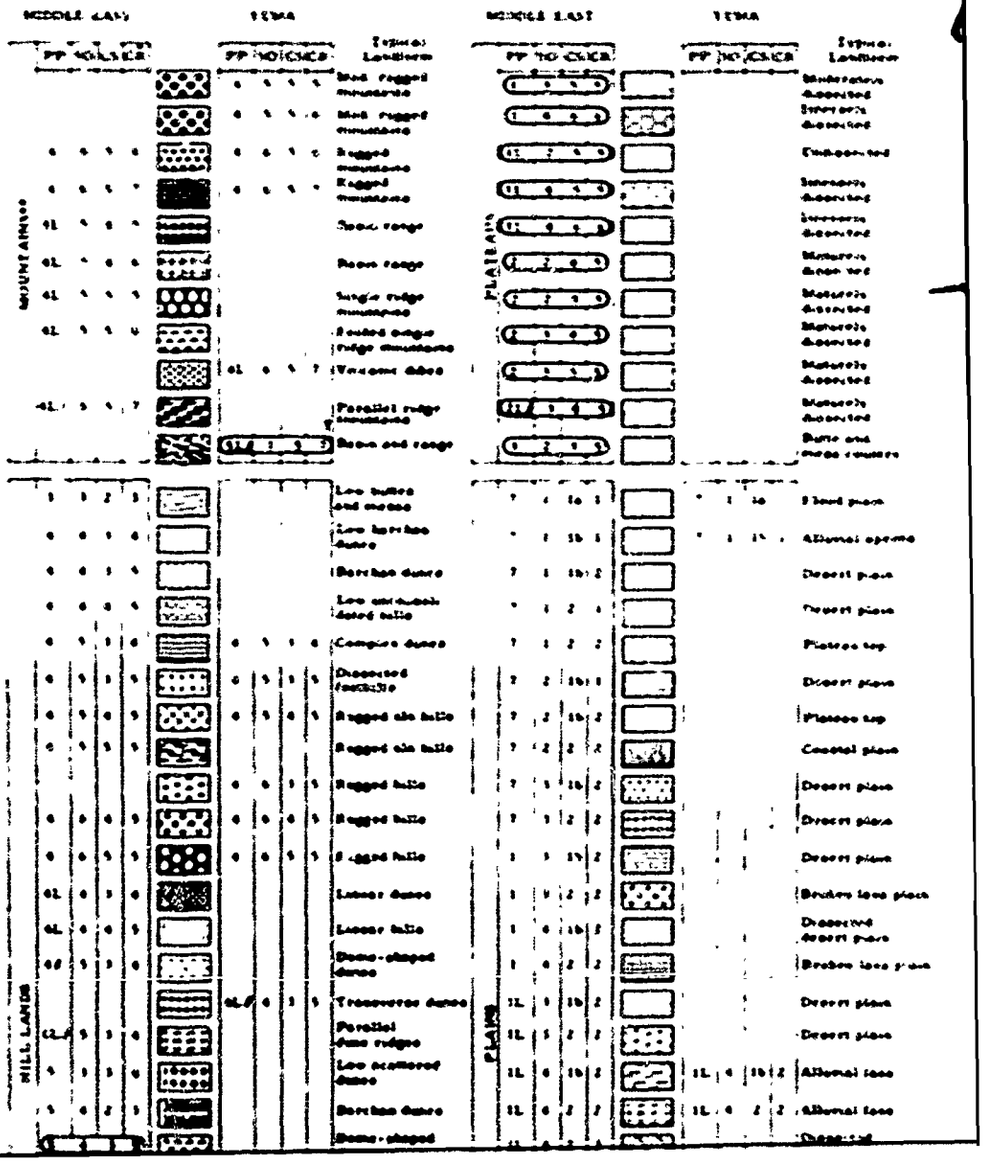


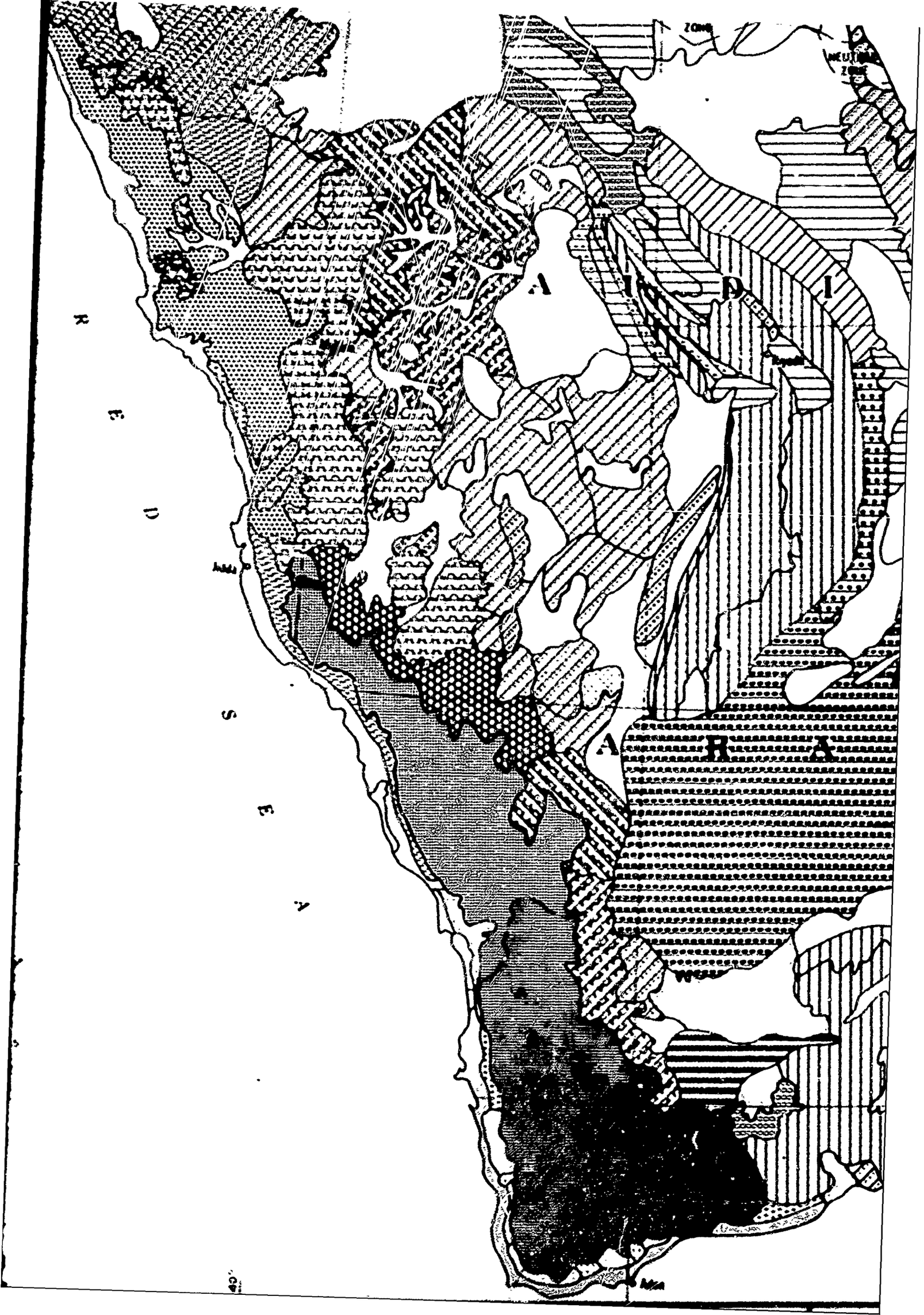
YUMA PROVING GROUND

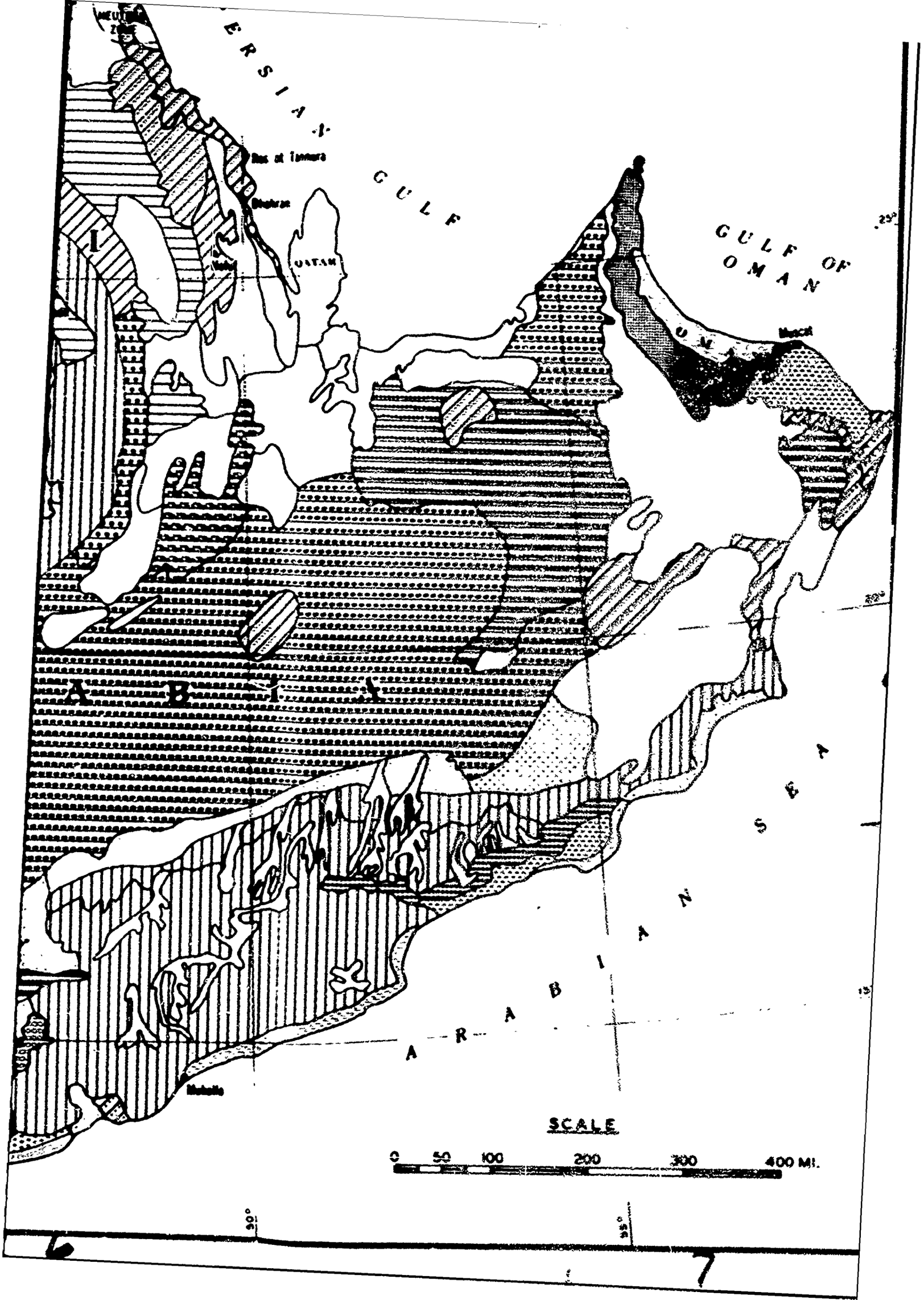
GROSS LANDSCAPE

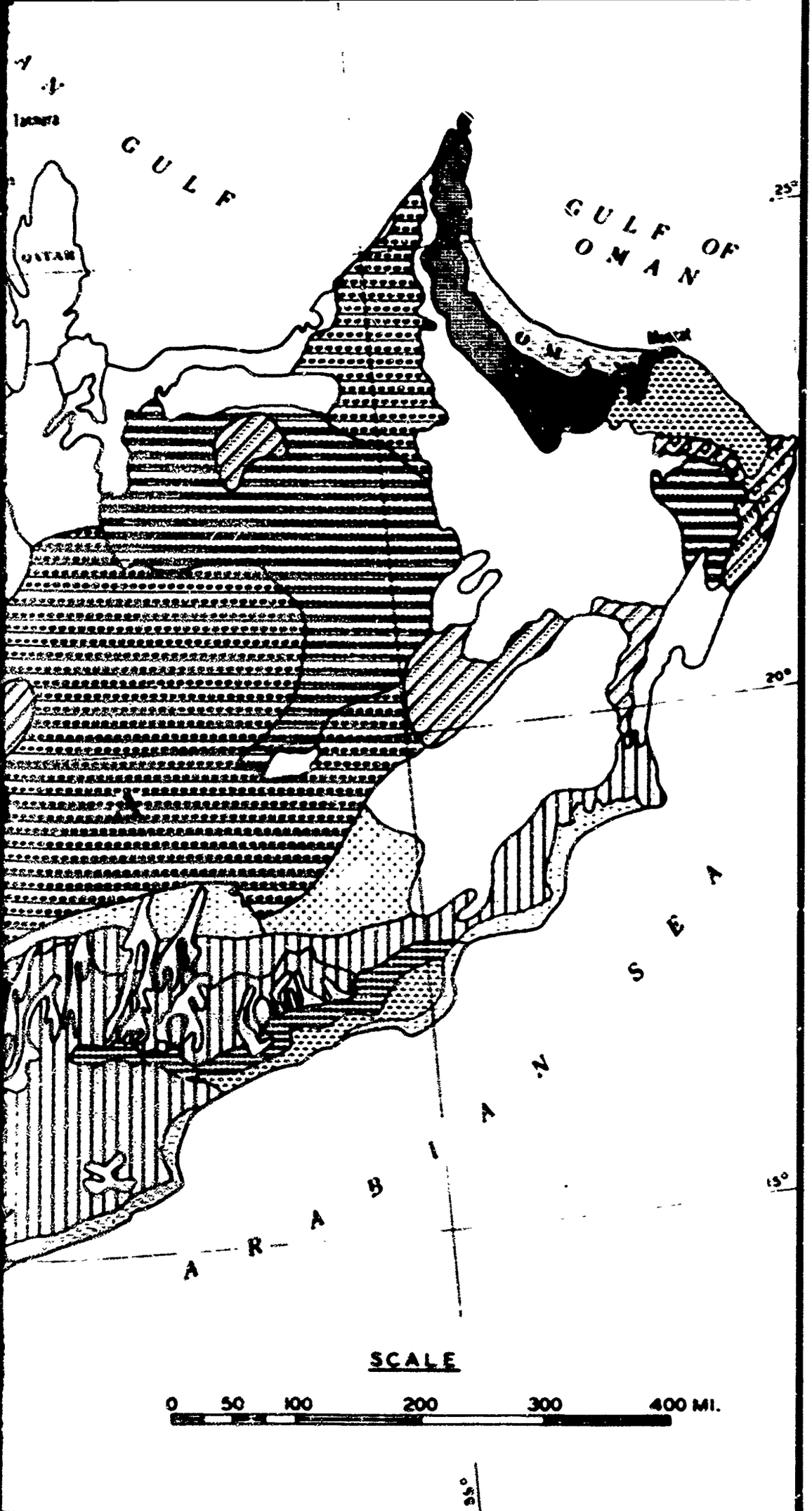
GENERALIZED LANDSCAPE

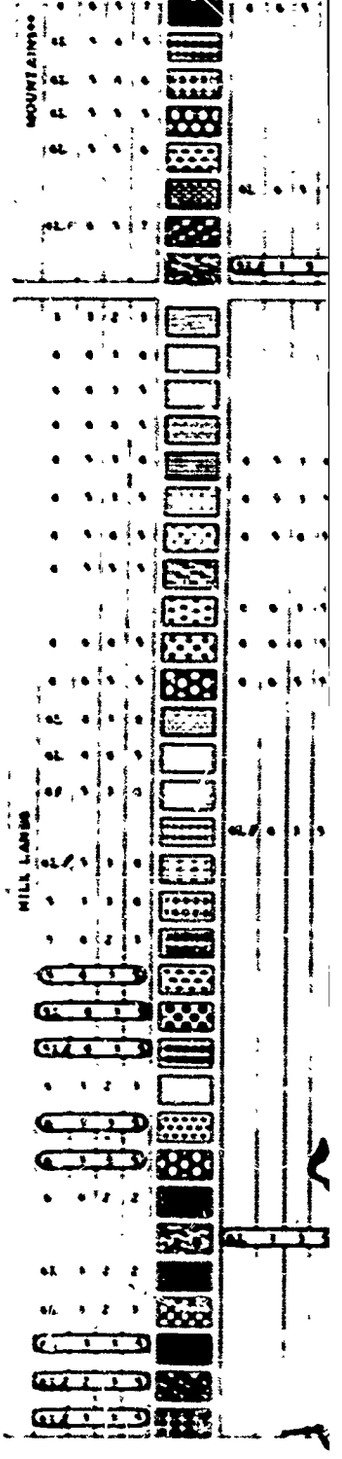







PERSIAN GULF
GULF OF OMAN
OMAN
Ras al Hamra
Muscat
Mukalla
I
A
B
SCALE
0 50 100 200 300 400 MI.

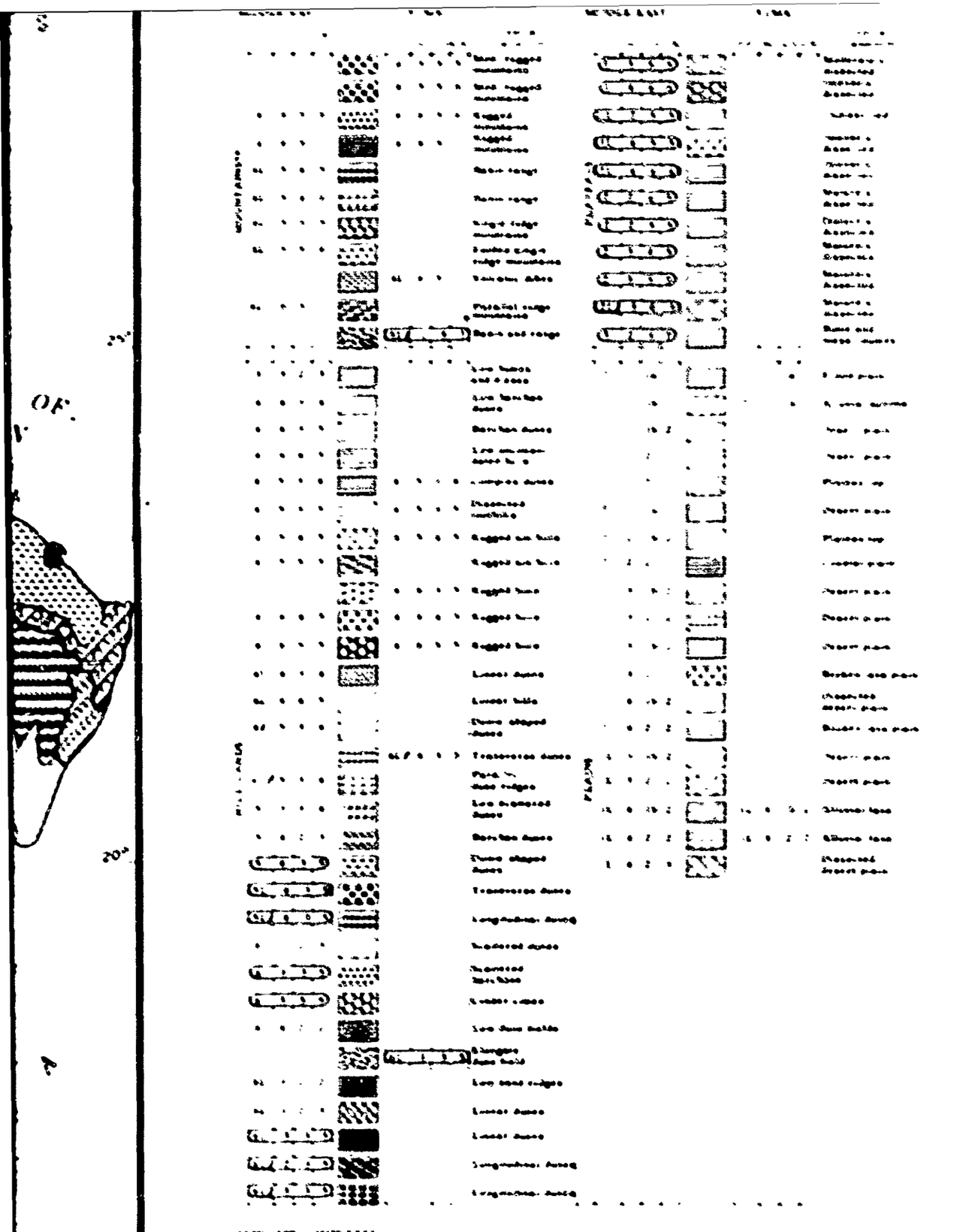




ANALO

MID

GENERA

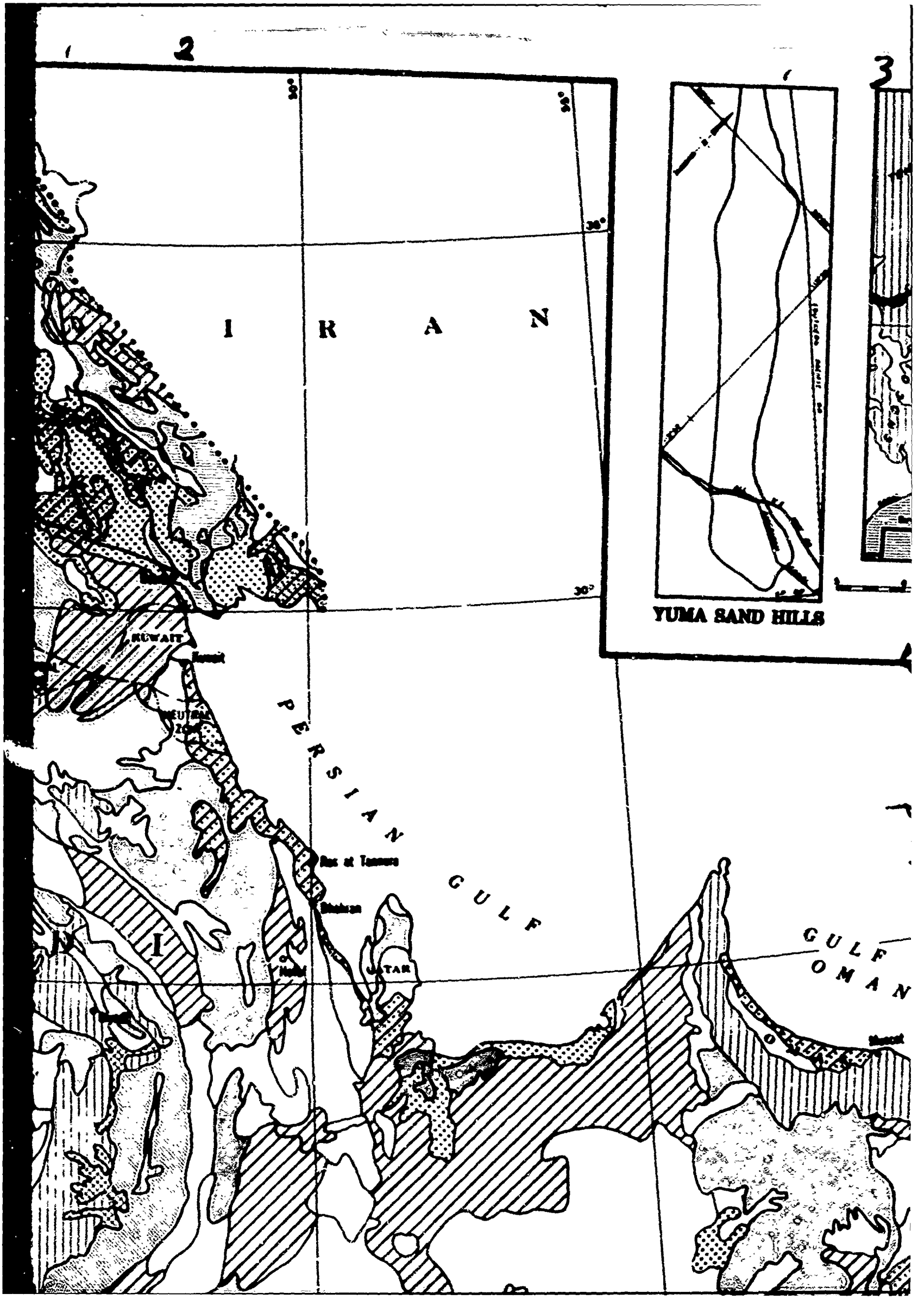


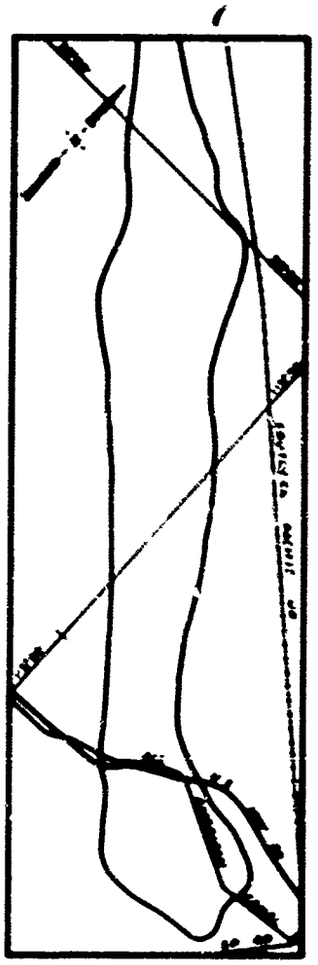
ANALOGS OF YUMA TERRAIN

IN THE

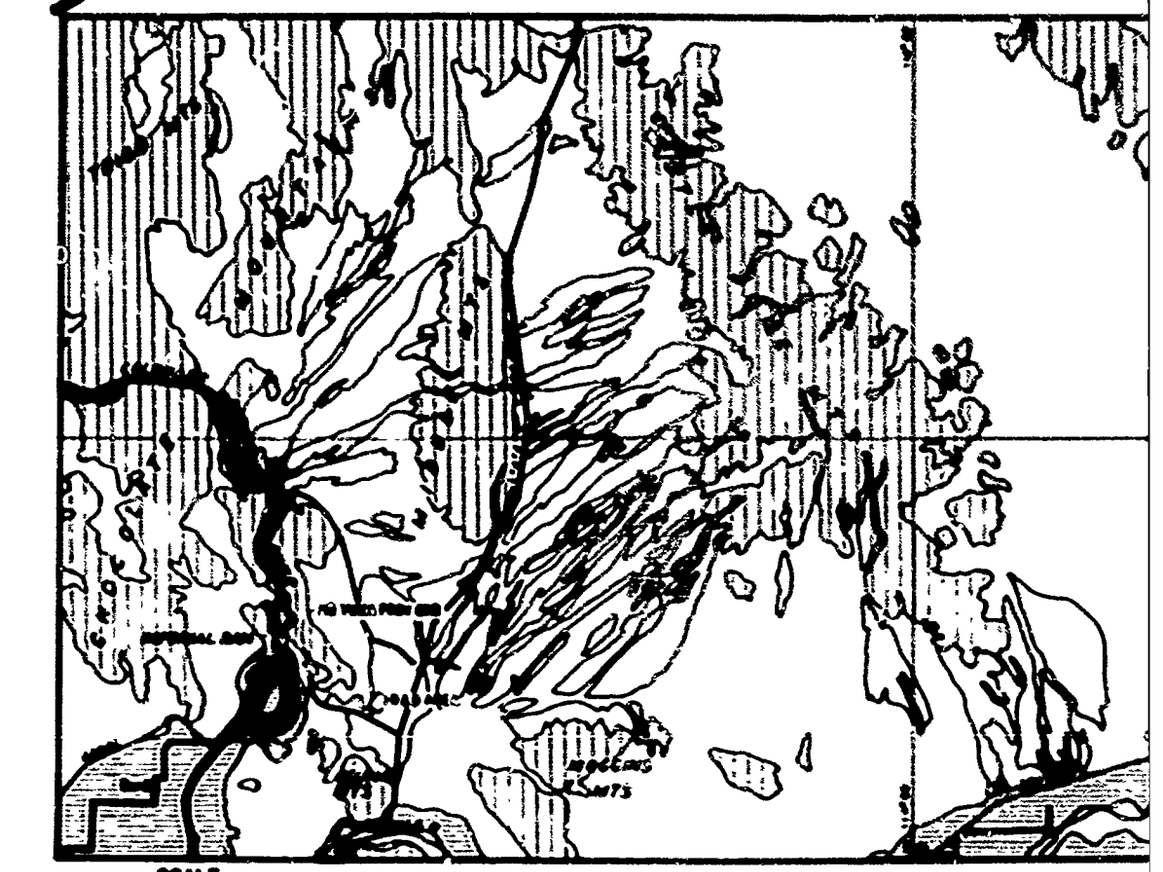
MIDDLE EAST DESERT

MEDITERRANEAN SEA
TIGRIS
RIVER
I R
S A U
R E D
35°
30°
29°

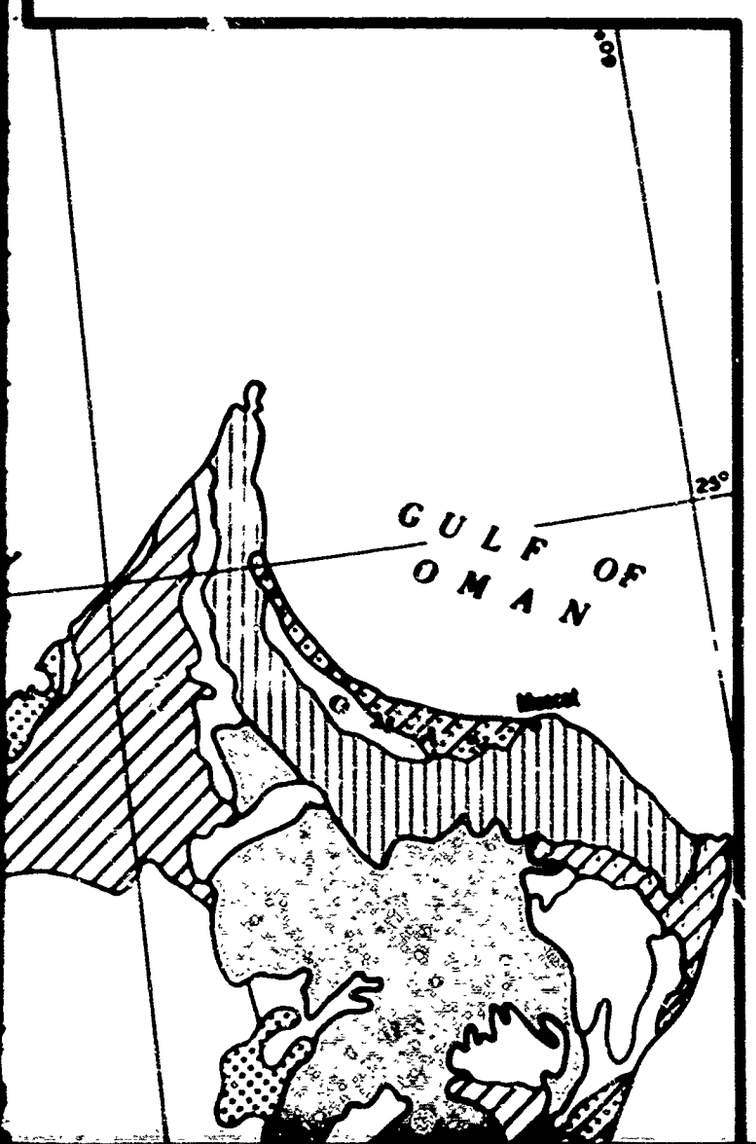

2
3
I R A N
PERSIAN GULF
GULF OF OMAN
KUWAIT
Kuwait
Bandar Abbas
Khasab
Muscat
YUMA SAND HILLS



YUMA SAND HILLS



YUMA PROVING GROUND



SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1. Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 90 per cent of the area mapped.

2. Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 90 per cent of the area mapped.

3. Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 10 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of volcanic ash or cystic

*Stony soils. More than 3% per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS*

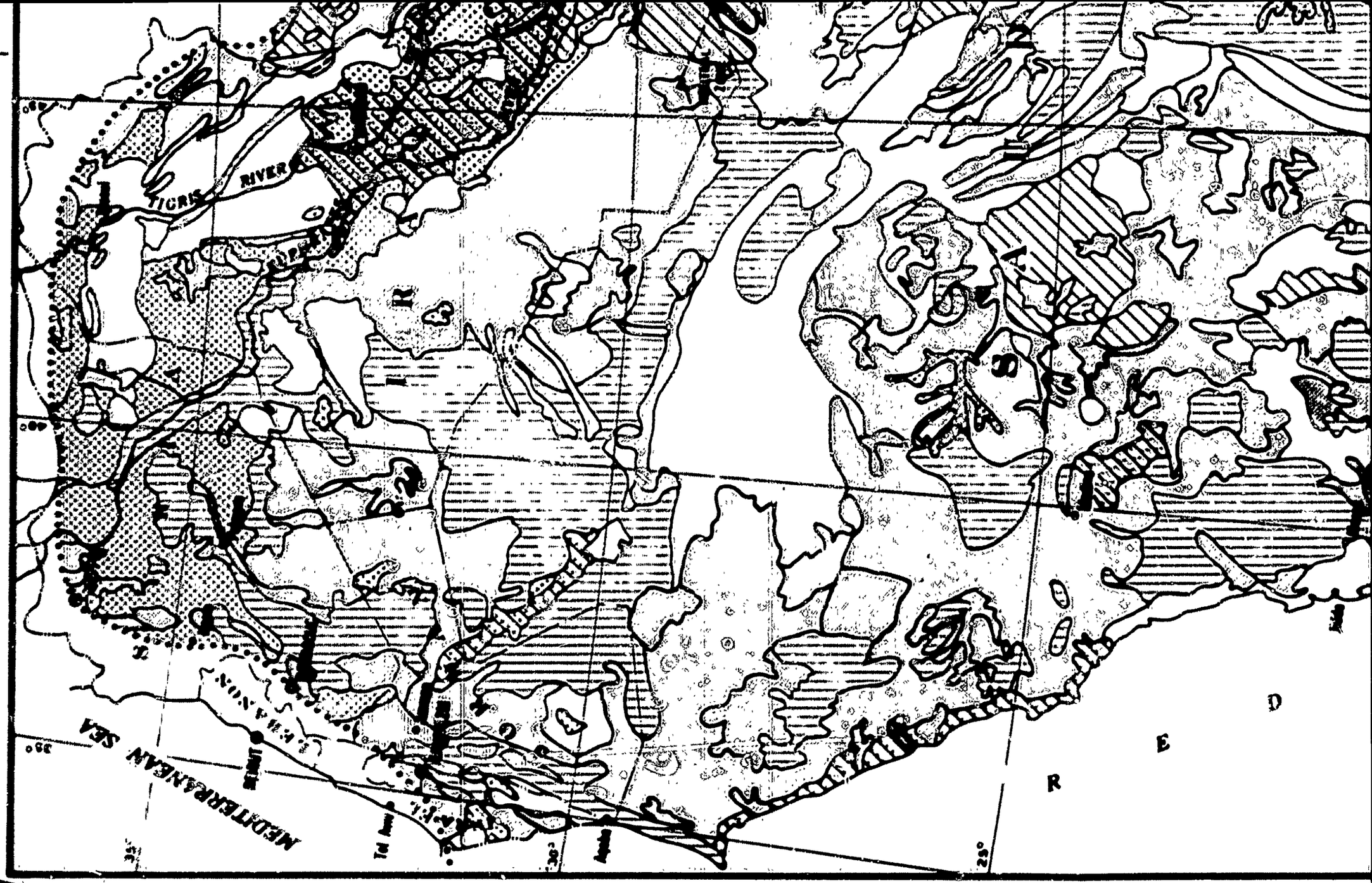
Areally predominant (70 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils

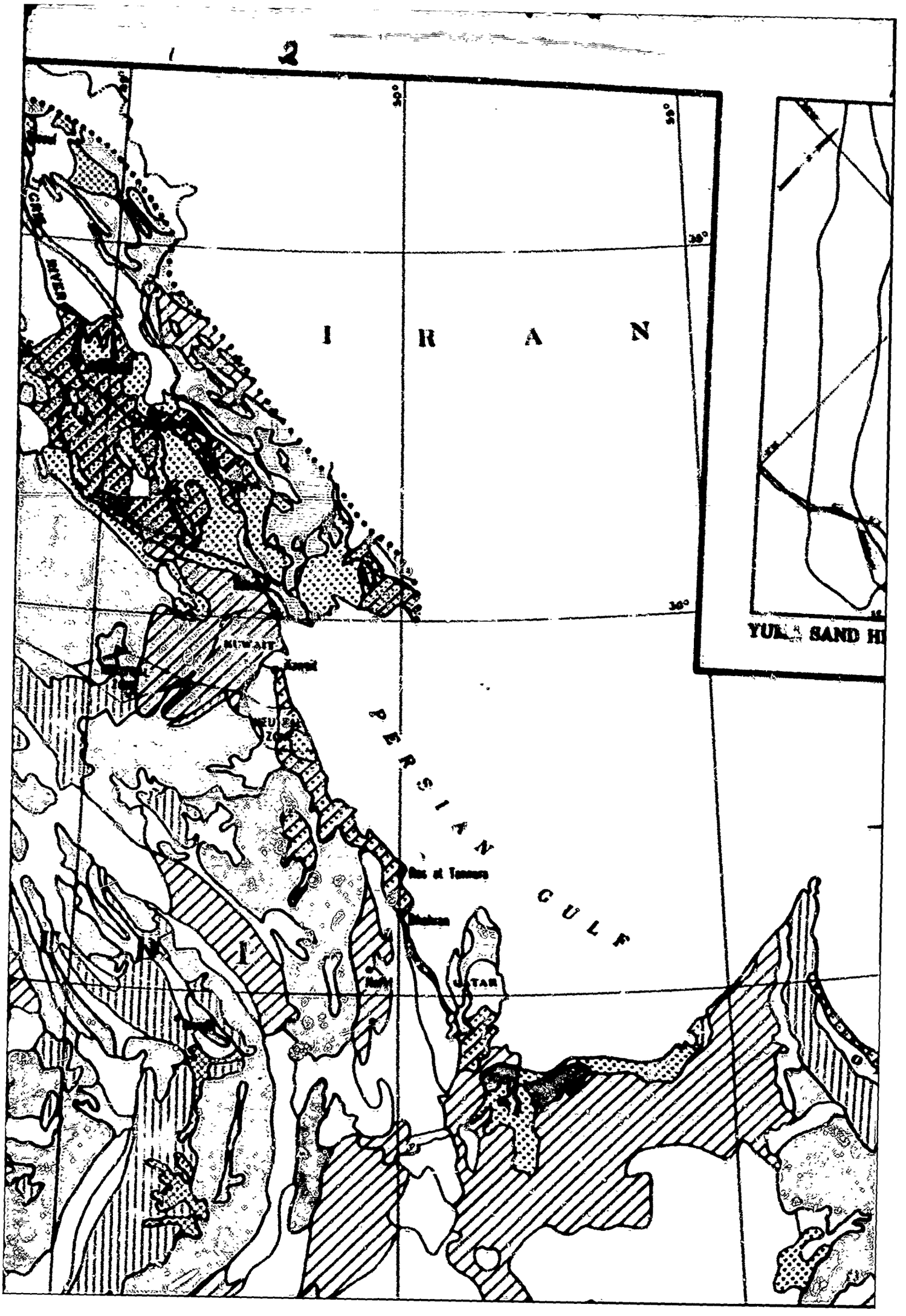
COARSE-GRAINED SOILS

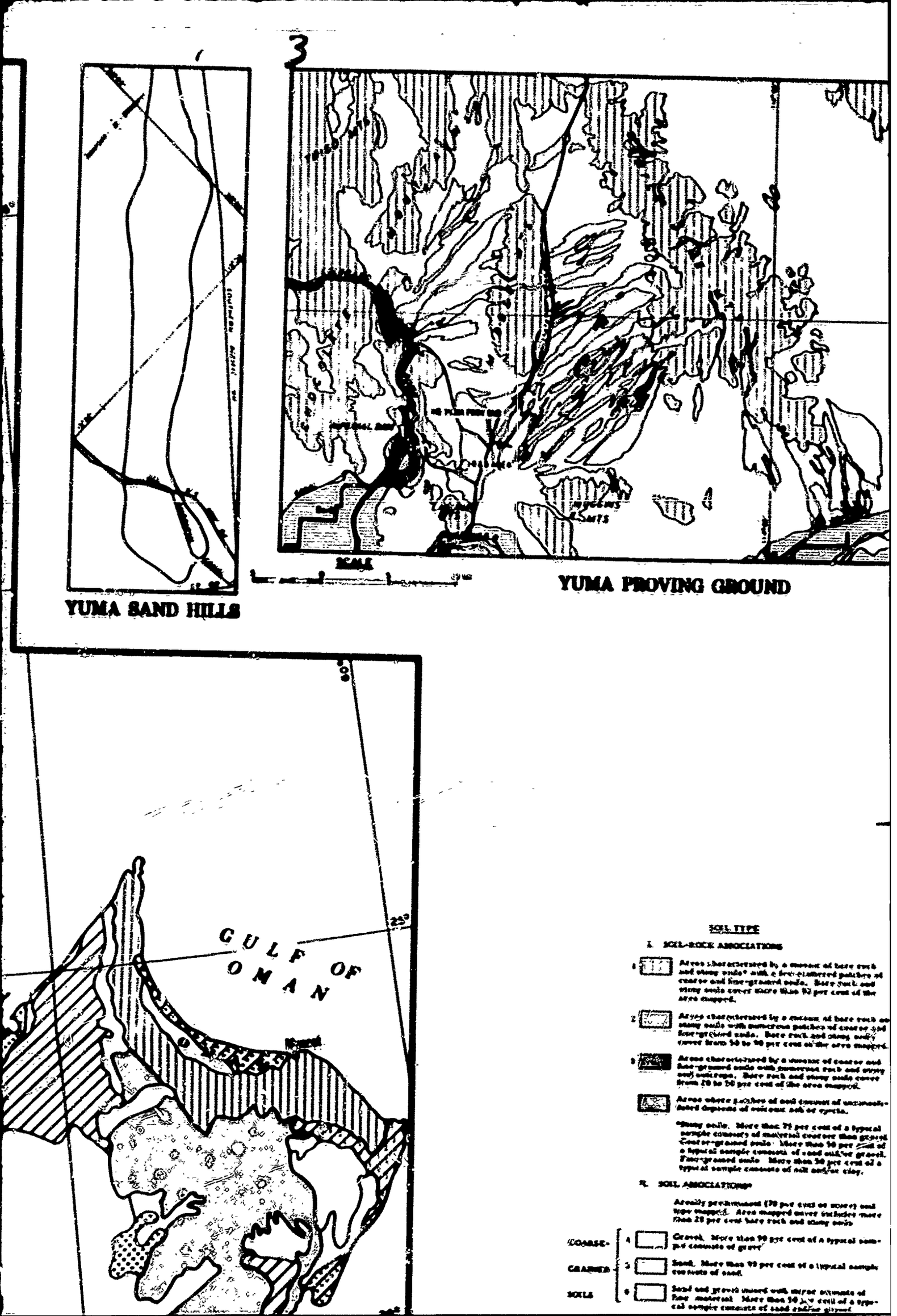
4. Gravel. More than 50 per cent of a typical sample consists of gravel

5. Sand. More than 50 per cent of a typical sample consists of sand

6. Sand and gravel mixed with minor amounts of fine-grained soils. More than 50 per cent of a typi-


TIGRIS RIVER
MEDITERRANEAN SEA
R
E
D


IRAN
PERSIAN GULF
KUWAIT
Kuwait
Ras al Tannura
Dhahran
TAR
YUL SAND HI


YUMA SAND HILLS
YUMA PROVING GROUND
SCALE
GULF OF OMAN
SOIL TYPE
I. SOIL-ROCK ASSOCIATIONS
II. SOIL ASSOCIATIONS*
COARSE-GRAINED SOILS
FINE-GRAINED SOILS

YUMA PROVING GROUND

SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1. Areas characterized by a mixture of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 50 per cent of the area mapped.

2. Areas characterized by a mixture of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 50 to 90 per cent of the area mapped.

3. Areas characterized by a mixture of coarse and fine-grained soils with numerous rock and stony outcrops. Bare rock and stony soils cover from 25 to 50 per cent of the area mapped.

Areas where patches of soil consist of unconsolidated deposits of relatively soft or coarse.

*Stony soils. More than 15 per cent of a typical sample consists of material greater than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of silt and/or clay.

II. SOIL ASSOCIATIONS

Actually predominant (50 per cent or more) soil type mapped. Area mapped never includes more than 20 per cent bare rock and stony soils.

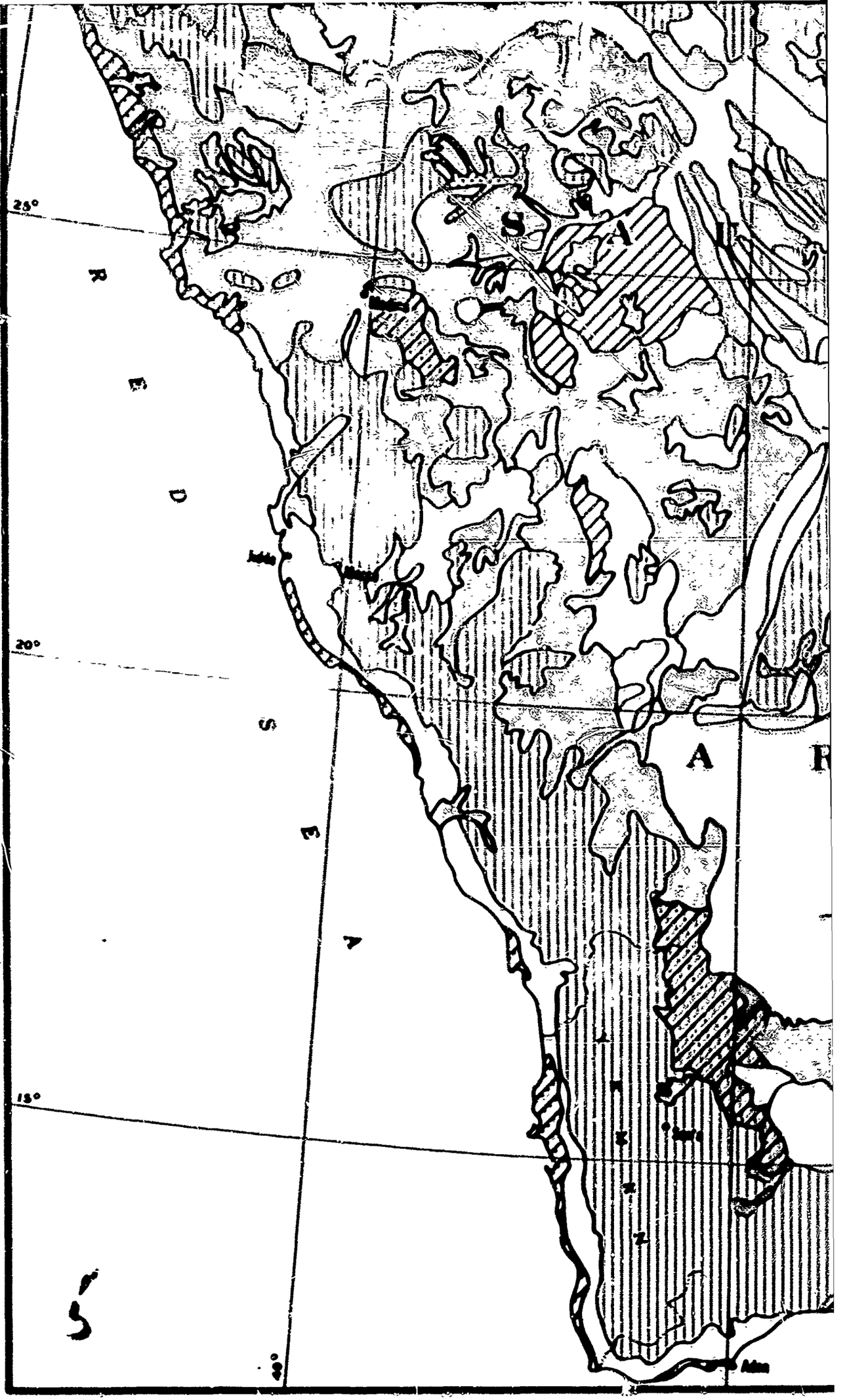
COARSE-GRAINED SOILS

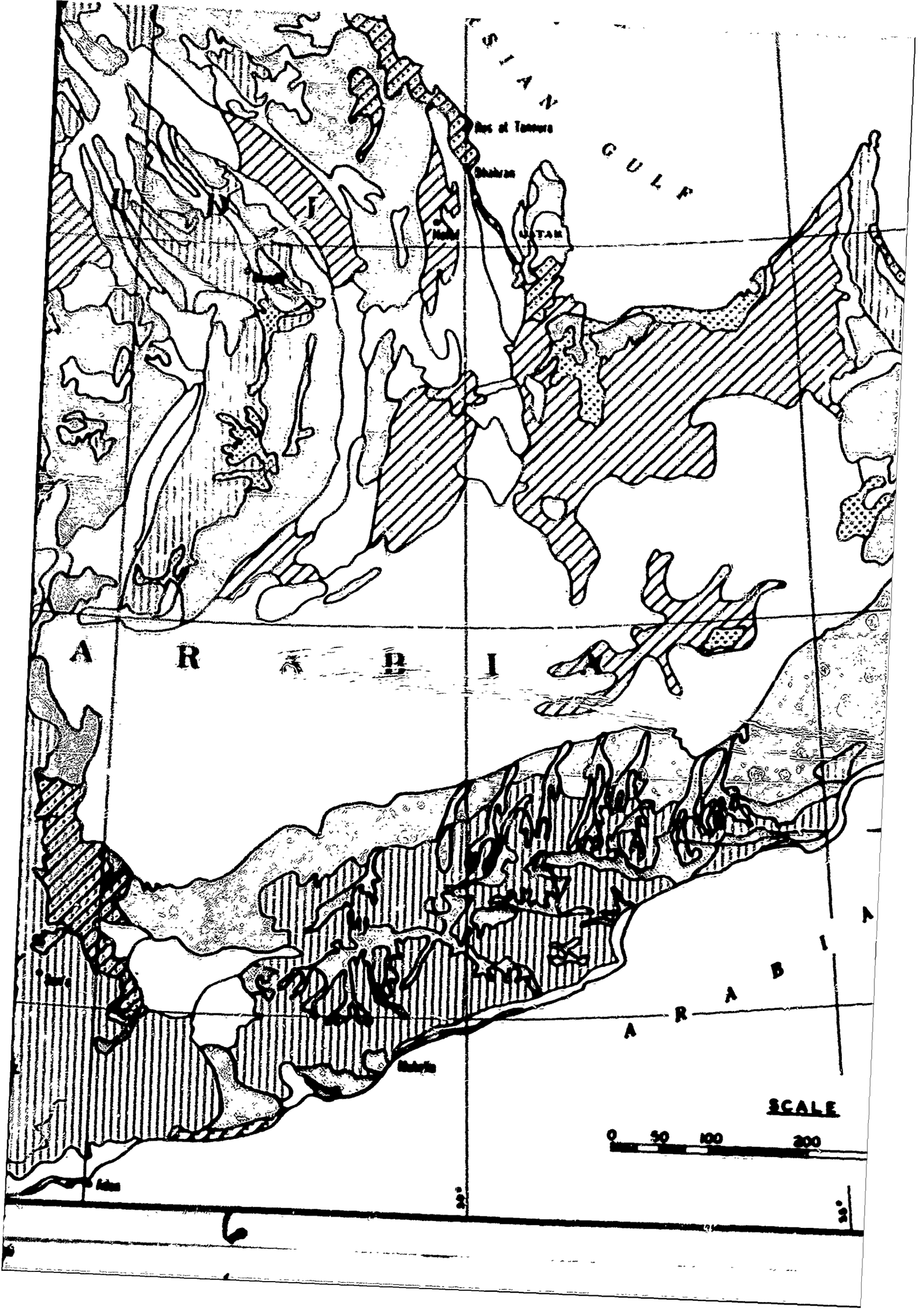
4. Gravel. More than 50 per cent of a typical sample consists of gravel.

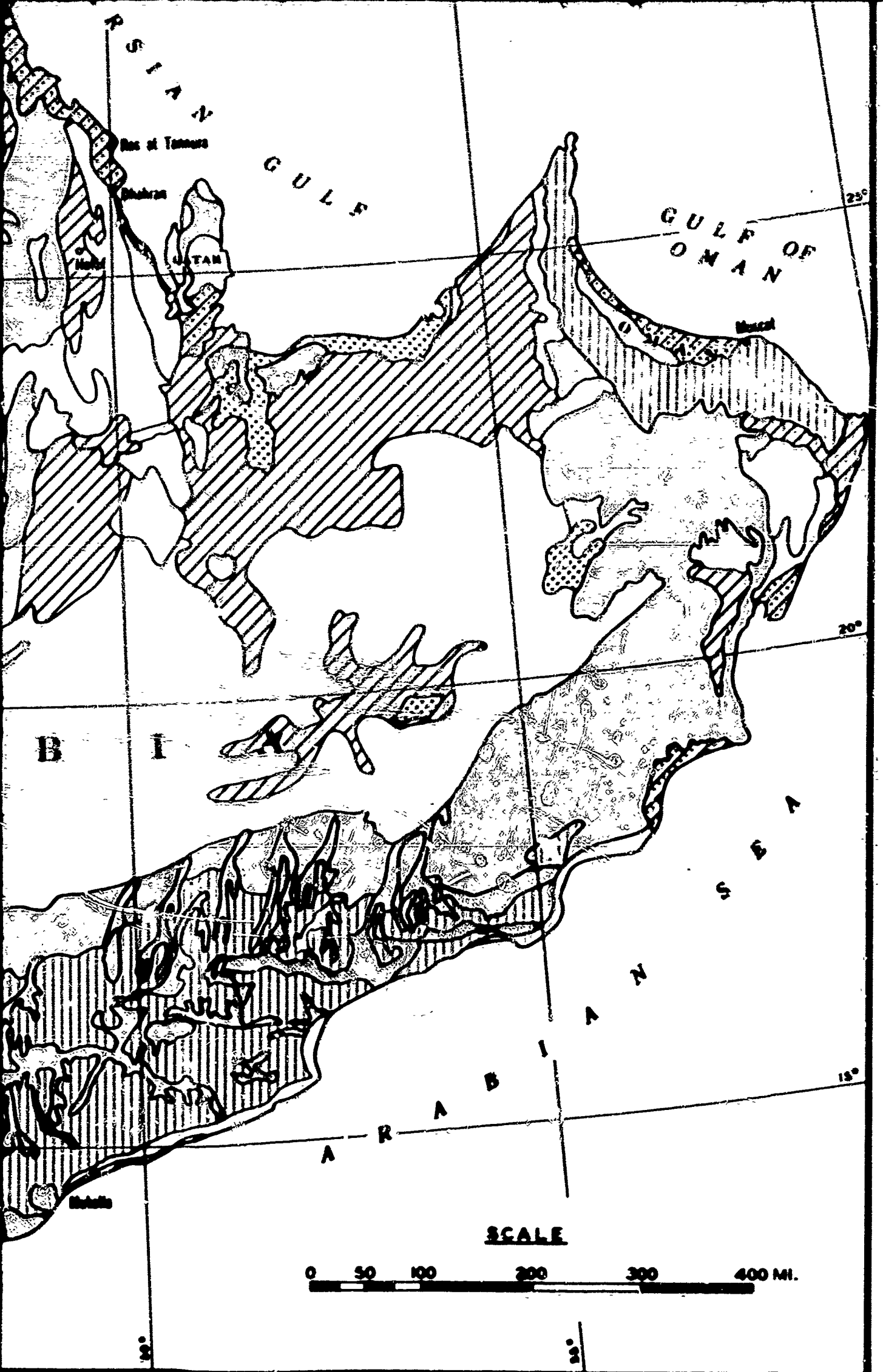
5. Sand. More than 50 per cent of a typical sample consists of sand.

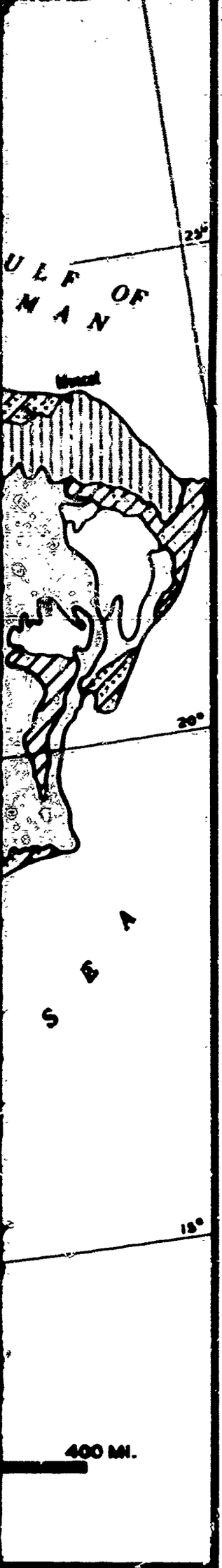
6. Sand and gravel mixed with minor amounts of finer material. More than 50 per cent of a typical sample consists of sand and/or gravel.

7. [illegible]


25°
20°
15°
RED SEA
SAUDI ARABIA
YEMEN


GULF
Ras al Tannura
Dhahran
Hofuf
QATAR
ARABIA
ARABIA
SCALE
0
50
100
200


PERSIAN GULF
GULF OF OMAN
Ras al Tannura
Bahrain
Doha
QATAR
Muscat
OMAN
25°
20°
15°
BIA
ARABIAN SEA
Aden
SCALE
0 50 100 200 300 400 MI.



SOIL TYPE

I. SOIL-ROCK ASSOCIATIONS

1 — Areas characterized by a mosaic of bare rock and stony soils* with a few scattered patches of coarse and fine-grained soils. Bare rock and stony soils cover more than 75 per cent of the area mapped.

2 — Areas characterized by a mosaic of bare rock and stony soils with numerous patches of coarse and fine-grained soils. Bare rock and stony soils cover from 55 to 75 per cent of the area mapped.

3 — Areas characterized by a mosaic of coarse and fine-grained soils with numerous rock and stony soil outcrops. Bare rock and stony soils cover from 25 to 55 per cent of the area mapped.

4 — Areas chiefly patches of soil consist of unconsolidated deposits of variant soil or types.

*Stony soils. More than 15 per cent of a typical sample consists of material coarser than gravel. Coarse-grained soils. More than 50 per cent of a typical sample consists of sand and/or gravel. Fine-grained soils. More than 50 per cent of a typical sample consists of soil and/or clay.

II. SOIL ASSOCIATIONS*

Areas chiefly predominant (75 per cent or more) soil type mapped. Areas mapped never include more than 25 per cent bare rock and stony soils.

COARSE-GRAINED SOILS

5 — Gravel. More than 75 per cent of a typical sample consists of gravel.

6 — Sand. More than 75 per cent of a typical sample consists of sand.

7 — Sand and gravel mixed with minor amounts of finer material. More than 75 per cent of a typical sample consists of sand and/or gravel.

FINE-GRAINED SOILS

8 — Silt and clay with minor amounts of coarser material. More than 50 per cent of a typical sample consists of silt and/or clay.

9 — Silt. More than 75 per cent of a typical sample consists of silt.

10 — Clay. More than 75 per cent of a typical sample consists of clay.

11 — Saline. A typical soil sample has a salt content of more than 25 per cent usually associated with silt and clay.

8/9 — SOIL COMPLEXES. Soil complexes are mapped where no specific predominant (75 per cent or more) soil type occurs. In such instances, the two most commonly occurring soil types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

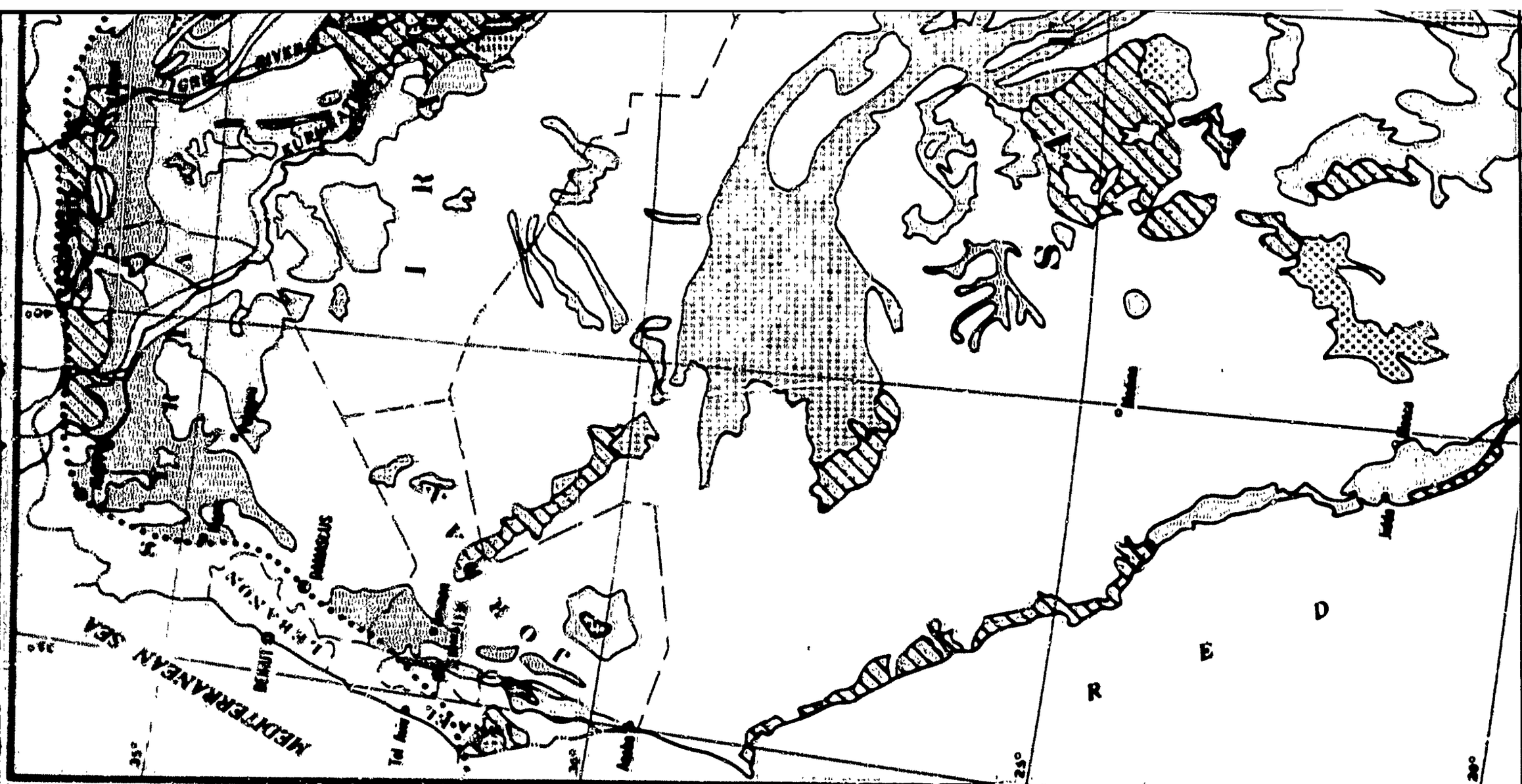
* In general soil associations exhibit soil thickness greater than 10 feet.

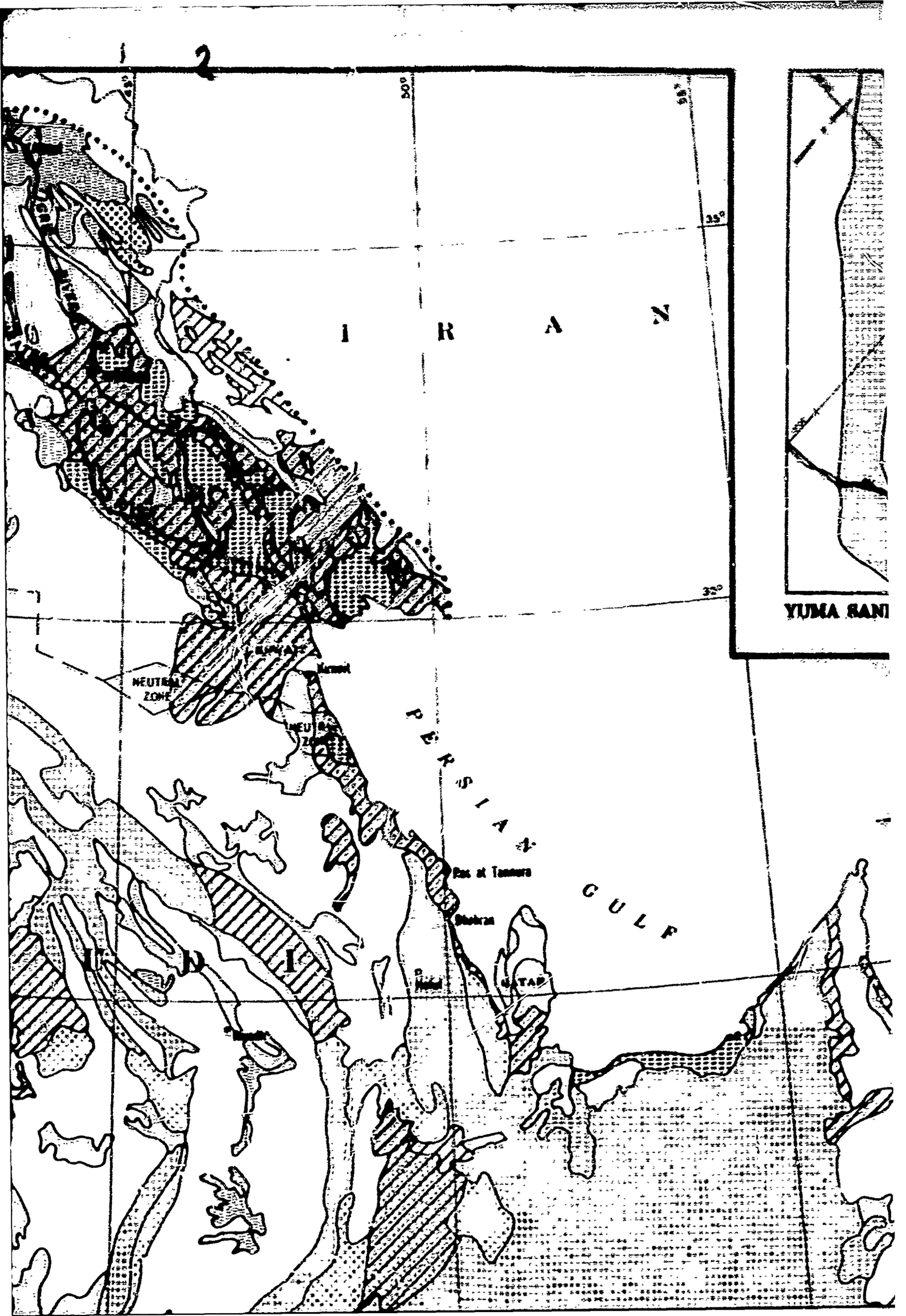
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT
SOIL TYPE

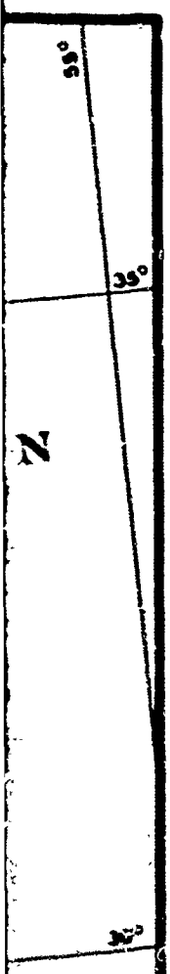
8

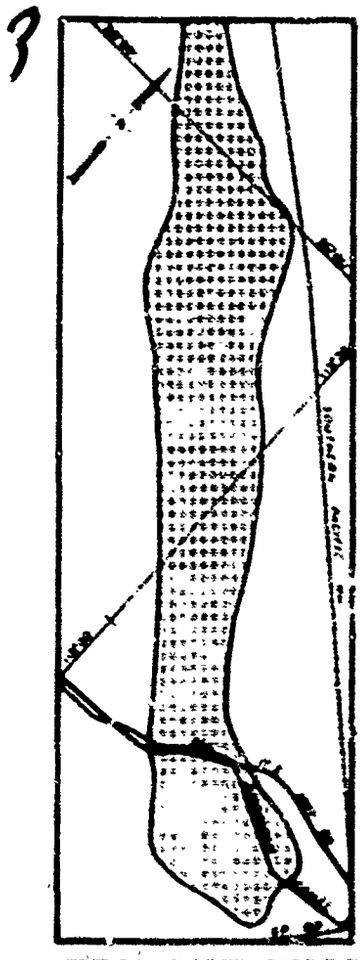
7

PLATE 6

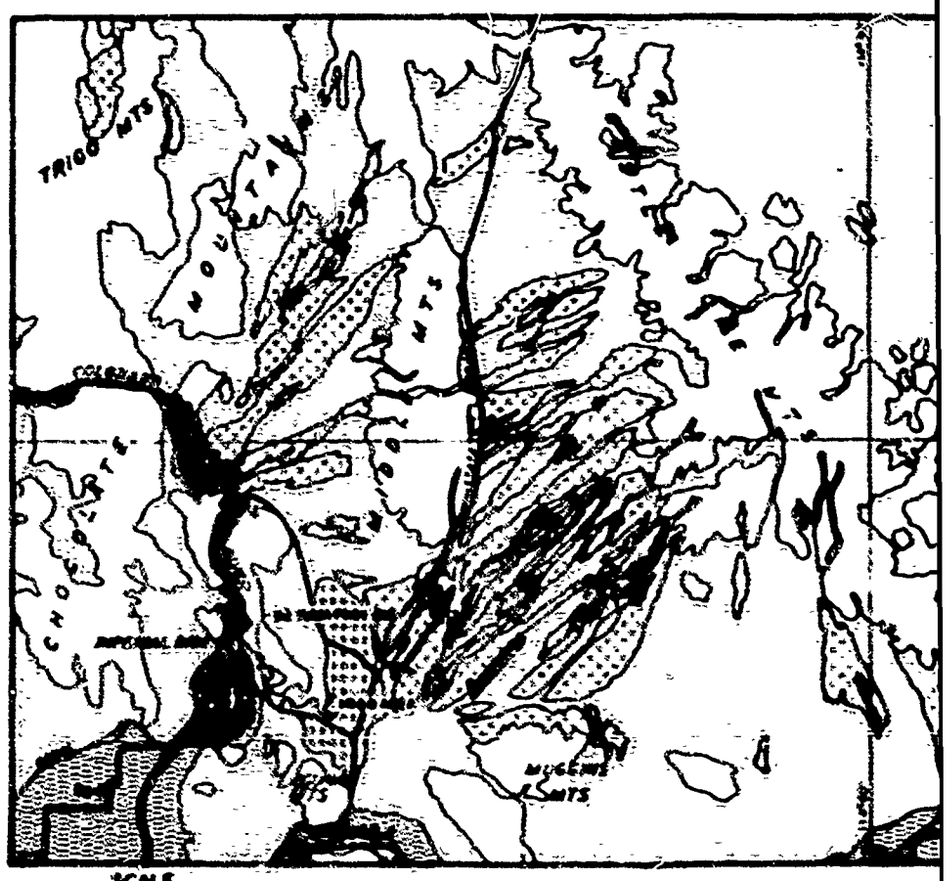

MEDITERRANEAN SEA
D
E
R


1
2
50°
55°
35°
30°
I R A N
YUMA SAN
NEUTRAL ZONE
Kuwait
PERSIAN GULF
Ras al Tannura
Bahrain
Doha
QATAR



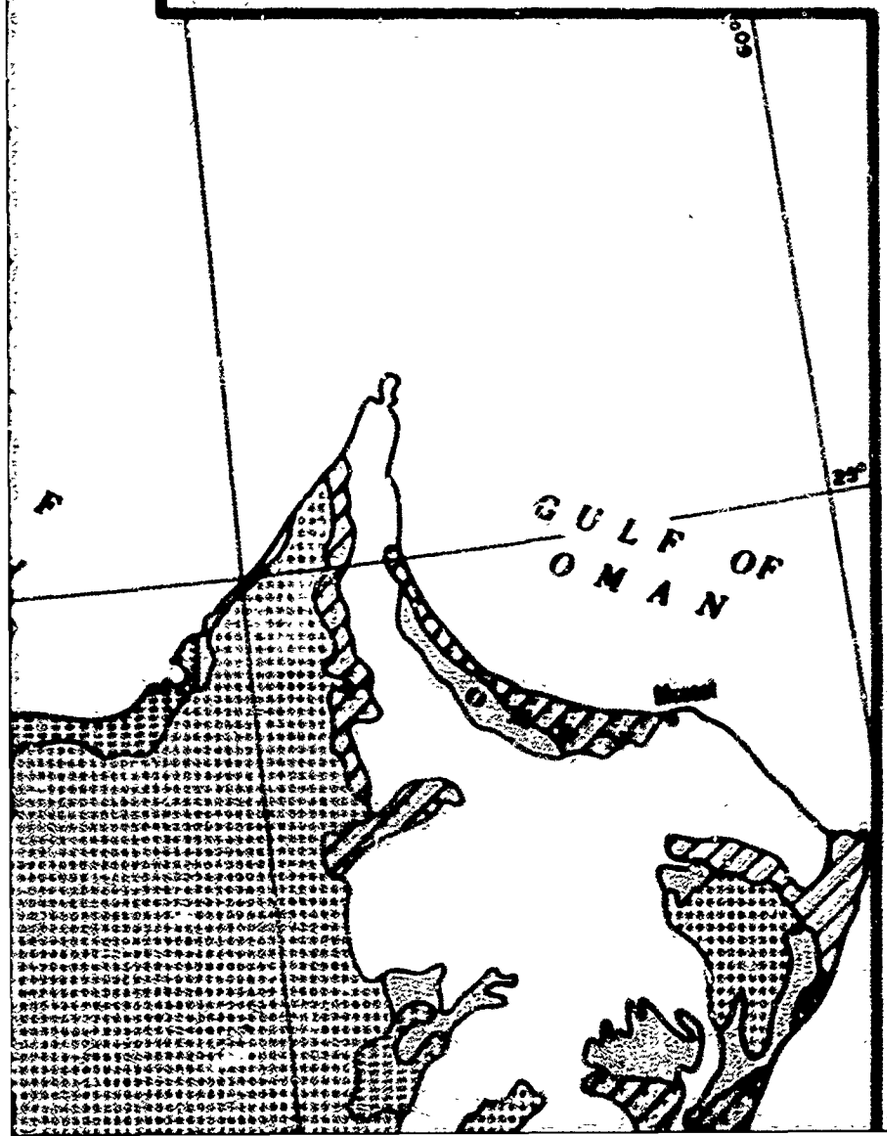


YUMA SAND HILLS



SCALE

YUMA PROVING GROUND



SOIL CONSISTENCY

Soil consistencies are mapped only where
Actually predominant (50 per cent or more) soil con

I. HOMOGENEOUS CONSISTENCIES: Soil
changed consistencies to depth greater

A. Noncohesive: Materials in which th
do not adhere to each other.

1 Loose: The ratio of voids to
close to a naturally occurring
grains are loosely packed.

2 Dense: The ratio of voids to
close to a naturally occurring
grains are closely packed.

B. Cohesive: Materials in which the
adhere to each other, offer increas
of the particles themselves, or have
a cementing material.

3 Soft (usually permeable soil,
capacity.

4 Firm: Moderate bearing capac

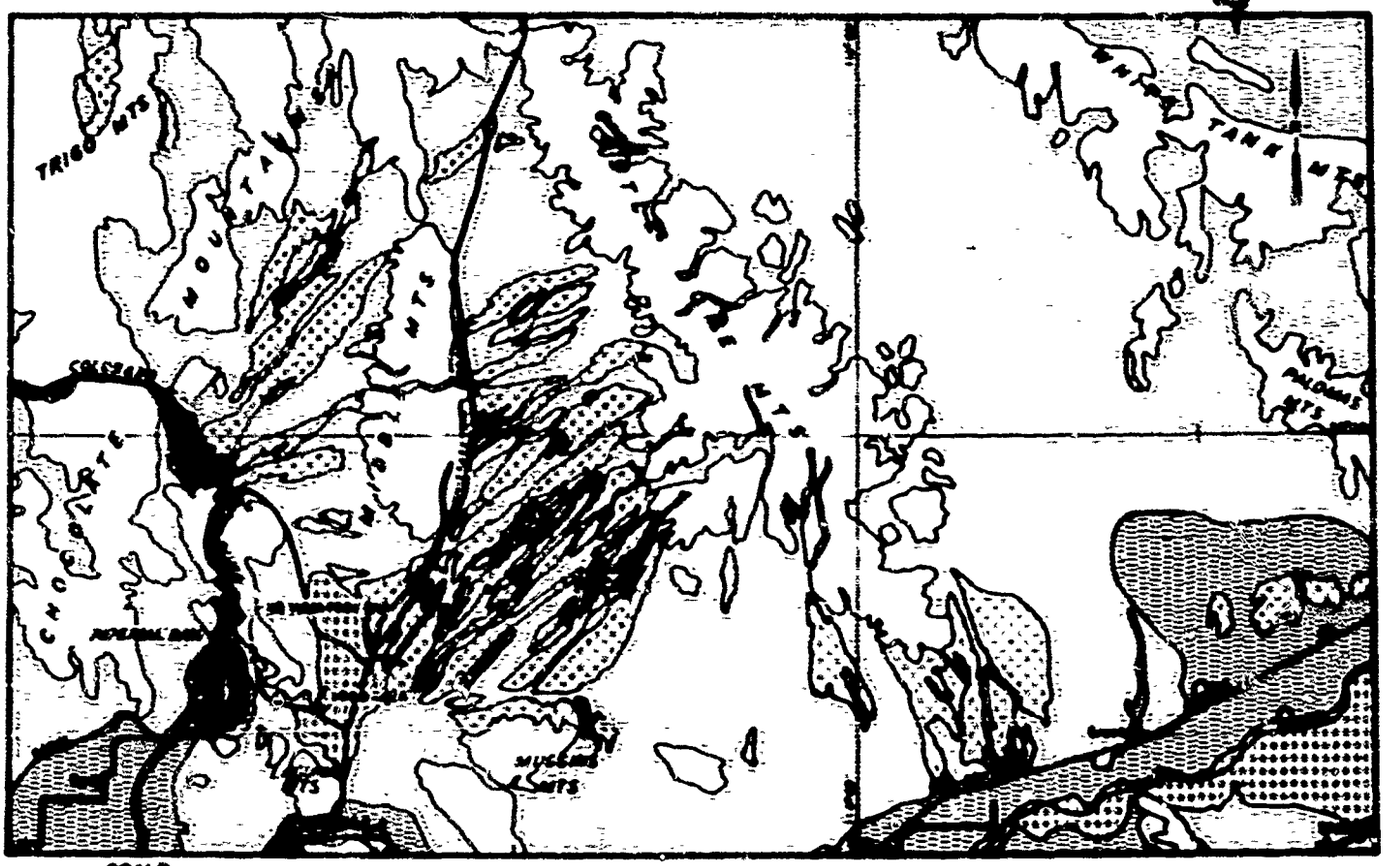
5 Hard: High bearing capacity.

II. LAYERED CONSISTENCIES: Soils pres
relatively discrete layers within 12 inch

A. Crusted Surfaces: Surface crust ma
consistence.

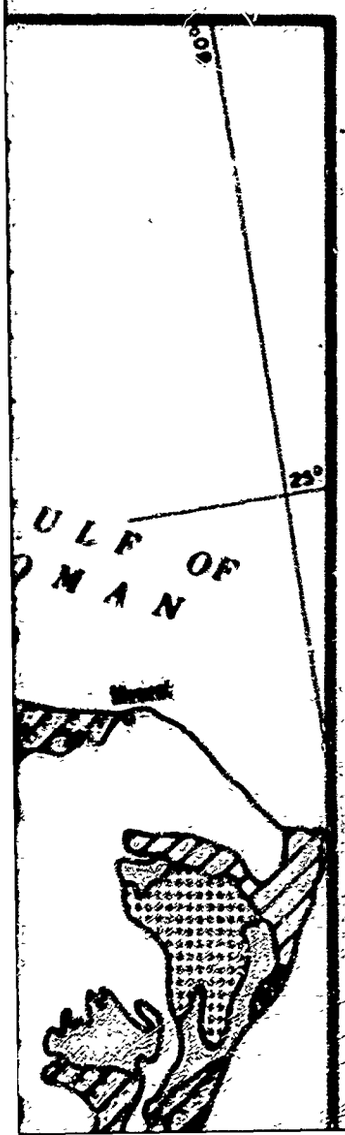
6 Hard thin crust (commonly of
overlying soft noncohesive
consist

7 Hard crust (commonly of
lying noncohesive material
soil.



SCALE

YUMA PROVING GROUND



SOIL CONSISTENCY

Soil consistencies are mapped only where soil associations occur. Areally predominant (50 per cent or more) soil consistency mapped.

I. NONCOHESIVE CONSISTENCIES: Soils of essentially unchanged consistencies to depth greater than 12 inches.

A. Noncohesive: Materials on which the constituent particles do not adhere to each other.

1 Loose: The ratio of voids to constituent grains so close to a maximum occurring maximum, i.e., the grains are loosely packed.

2 Dense: The ratio of voids to constituent particles so close to a naturally occurring maximum, i.e., the grains are closely packed.

B. Cohesive: Materials on which the constituent particles adhere to each other, either because of mutual attraction of the particles themselves, or because of the presence of a cementing material.

3 Soft (usually permeable soil): Little or no bearing capacity.

4 Firm: Moderate bearing capacity.

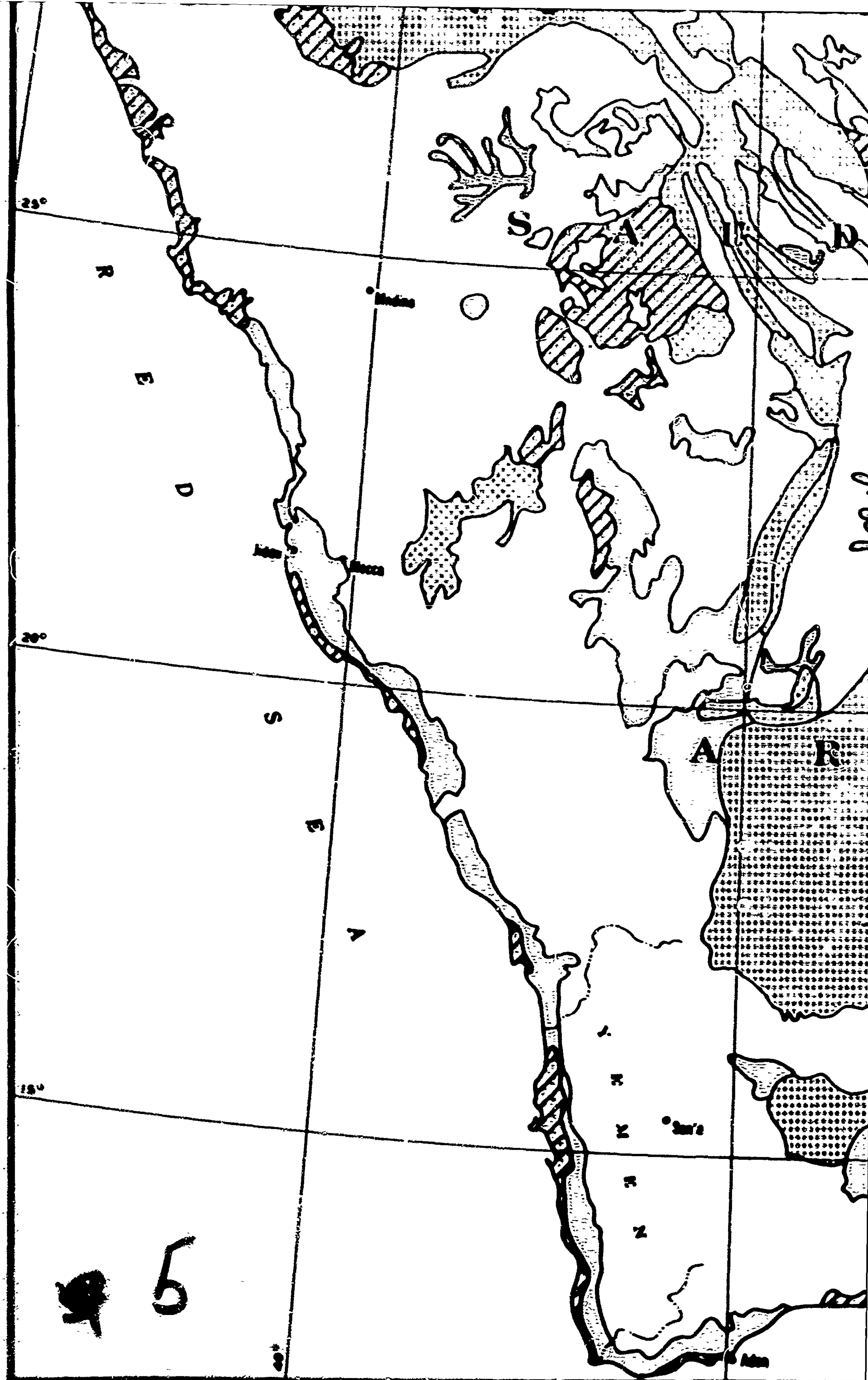
5 Hard: High bearing capacity.

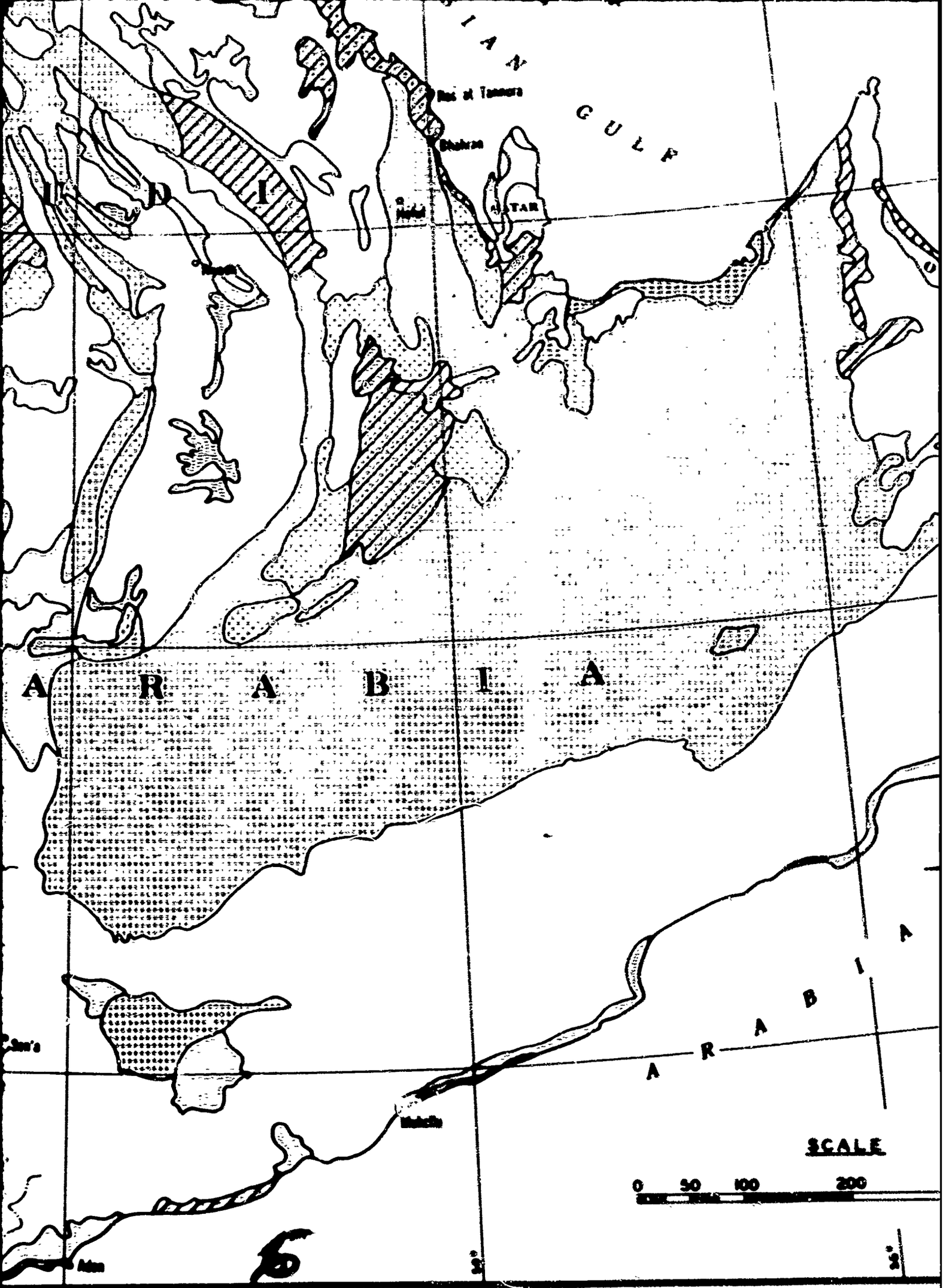
II. LAYERED CONSISTENCIES: Soils possessing two or more relatively discrete layers within 12 inches of the surface.

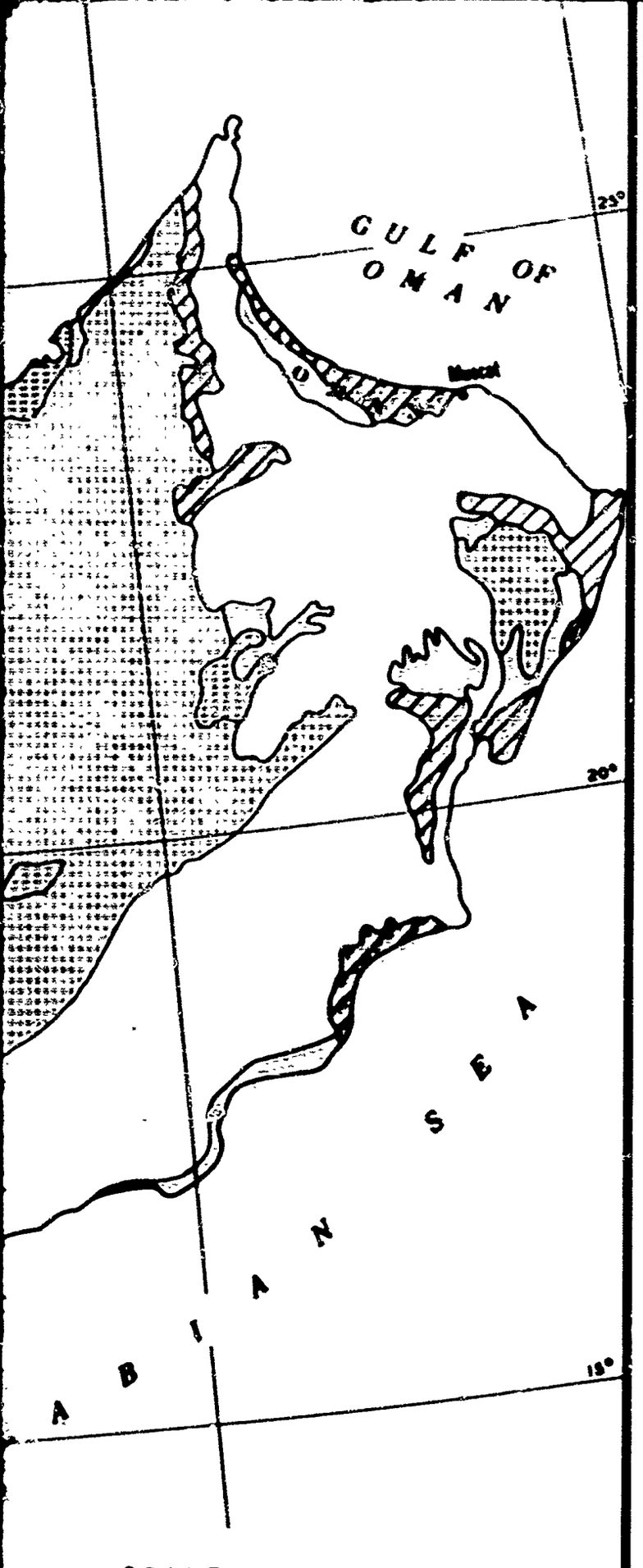
A. Crusted Surfaces: Surface crust may be either cohesive or noncohesive.

6 Hard thin crust (commonly of cemented material overlying soft material (commonly moist, wet, or saturated soils).

7 Hard crust (commonly of cemented material) overlying noncohesive material (commonly sand or silt).


25°
20°
15°
R E D S E A
Medina
Jidda
Mecca
Aden


GULF
Ras al Tannura
Dhahran
Hofuf
Riyadh
TAM
ARABIA
ARABIA
SCALE
0 50 100 200
Abha



SOIL CONSISTENCY

Soil consistence are mapped only where soil associations Aridisols predominate (75 per cent or more) soil consistency mapp

I. HOMOGENEOUS CONSISTENCIES: Soils of essentially changed consistence to depth greater than 12 inches.

A. Noncoherent: Materials in which the constituent pa do not adhere to each other.

1 Loose: The ratio of voids to constituent grain closer to a naturally occurring minimum, i.e., grains are loosely packed.

2 Dense: The ratio of voids to constituent parti closer to a naturally occurring maximum, i.e., grains are closely packed.

B. Coherent: Materials in which the constituent parti adhere to each other, either because of mutual attr of the particles themselves, or because of the pres a cementing material

3 Soft (usually permanently wet). Little or no be capacity.

4 Firm: Moderate bearing capacity

5 Hard. High bearing capacity.

II. LAYERED CONSISTENCIES: Soils possessing two or m resistive discrete layers within 12 inches of the surfac

A. Crusted Surfaces: Surface crust may be either coh noncoherent.

6 Hard thin crust (commonly of cemented materi overlying soft materials (commonly moist, unc saturated soils).

7 Hard crust (commonly of cemented materials) lying noncoherent material (commonly sand or coarse.

8 Thin zone of firm materials over noncoherent rocks. (Most common development on areas of dunes, with more or less continuous vegetation cover.)

C Surface of closely-fitted noncoherent pebbles o gravel overlying noncoherent materials (comm sand or silt). (Such "desert pavements" also o over bedrock or materials of firm consistence thin to less common.)

B. Noncoherent surface layer less than 12 inches thick.

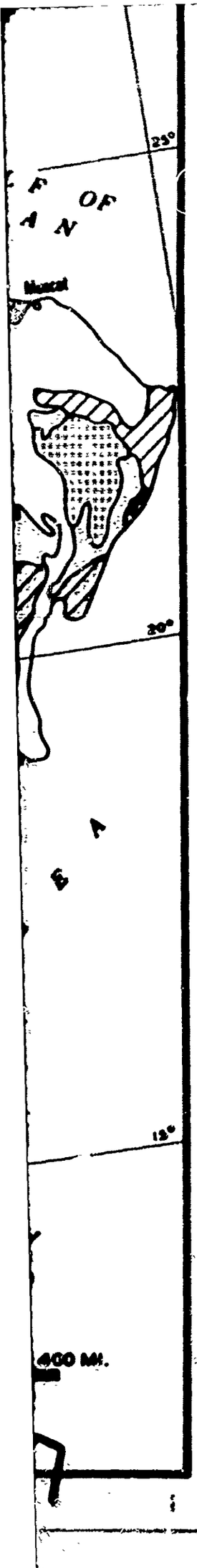
10 Dense layer within 12 inches of the surface.

20 Hard layer within 12 inches of the surface (may not always combine).

6/3 CONSISTENCY COMPLEXES: Consistency com are mapped where no areally predominant (75 p cent or more) consistency occurs. In such land the two most commonly occurring consistence mapped, the predominant is shown as the (dom the subordinate as the denominator in the fract pattern.

In complexes (e.g., 3/6) the first digit always refers to the areally dominant unit.

ANALOGS OF YUMA TERRA
IN THE
MIDDLE EAST DESERT
SOIL CONSISTENCY



SOIL CONSISTENCY

Soil consistencies are mapped only where soil associations occur areally predominant (70 per cent or more) soil consistency mapped.

I. NONINDURATED CONSISTENCIES. Soils of essentially unchanged consistence to depth greater than 12 inches.

A. Noncohesive: Materials in which the constituent particles do not adhere to each other.

1 Loose. The ratio of voids to constituent grains as close to a naturally occurring maximum, i.e., the grains are loosely packed.

2 Dense. The ratio of voids to constituent particles as close to a naturally occurring minimum, i.e., the grains are closely packed.

B. Cohesive. Materials in which the constituent particles adhere to each other, either because of mutual attraction of the particles themselves, or because of the presence of a cementing material.

3 Soft (usually yet unusually wet). Little or no bearing capacity.

4 Firm. Moderate bearing capacity.

5 Hard. High bearing capacity.

II. LAYERED CONSISTENCIES. Soils possessing two or more relatively discrete layers within 12 inches of the surface.

A. Crusted Surface. Surface crust may be either cohesive or noncohesive.

6 Hard thin crust (commonly of cemented materials) overlying soft materials (commonly mucky, loose, or saturated silts).

7 Hard crust (commonly of cemented materials) overlying noncohesive material (commonly sand or silt).

8 Thin veneer of loose materials over noncohesive materials. (Most common development in areas of fixed dunes, with more or less continuous vegetative cover.)

9 Surface of closely-fitted noncohesive pebbles or gravel overlying noncohesive materials (commonly sand or silt). Such "desert pavements" also occur over bedrock or materials of firm consistencies, but this is less common.)

B. Noncohesive surface layer less than 12 inches thick.

10 Loose layer within 12 inches of the surface.

11 Hard layer within 12 inches of the surface usually but not always cemented.

4/3 CONSISTENCY COMPLEXES. Consistency complexes are mapped where no areally predominant (70 per cent or more) consistency occurs. In such instances, the two most commonly occurring consistencies are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

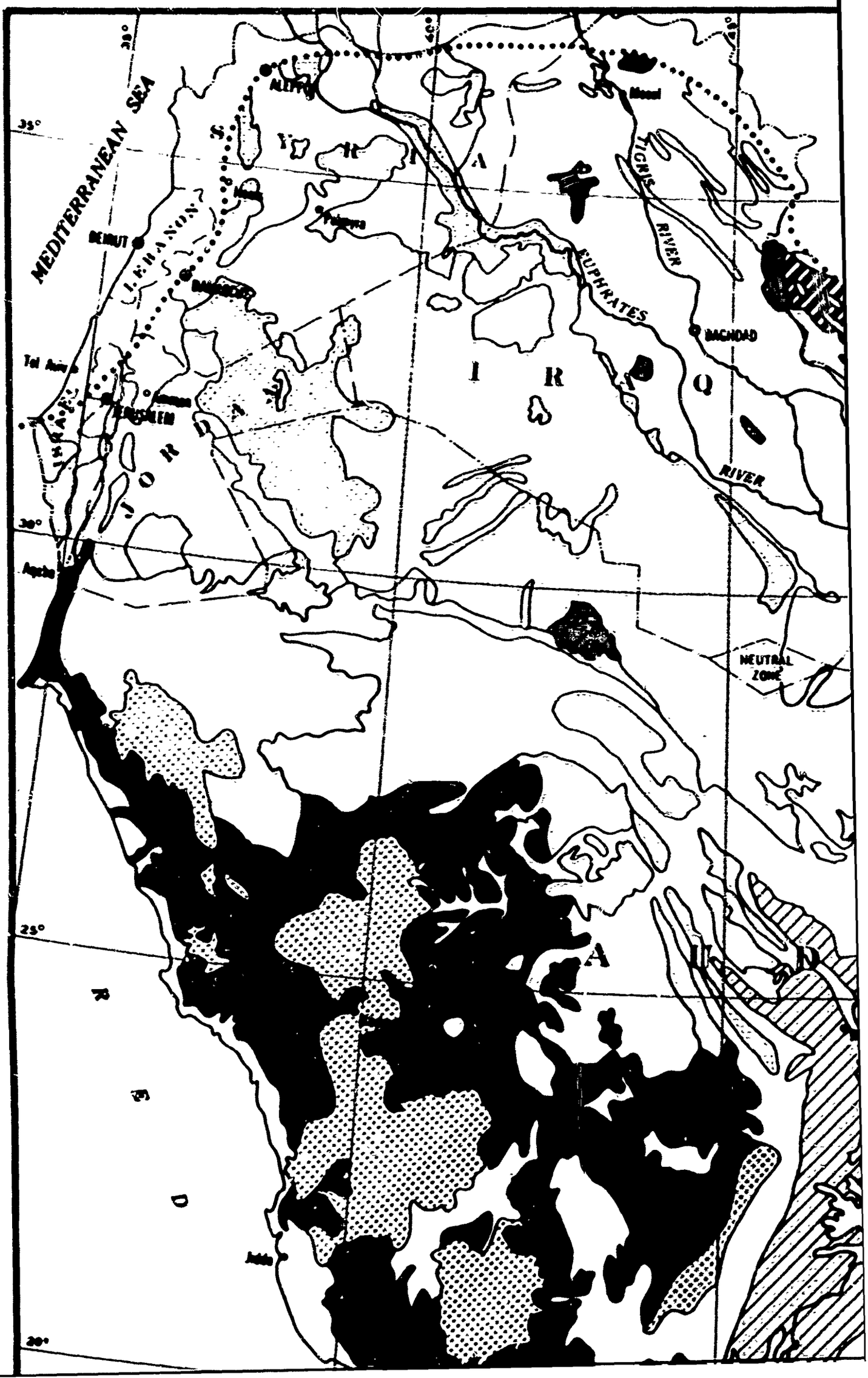
In complexes (e.g., 4/3) the first digit always refers to the areally predominant unit.

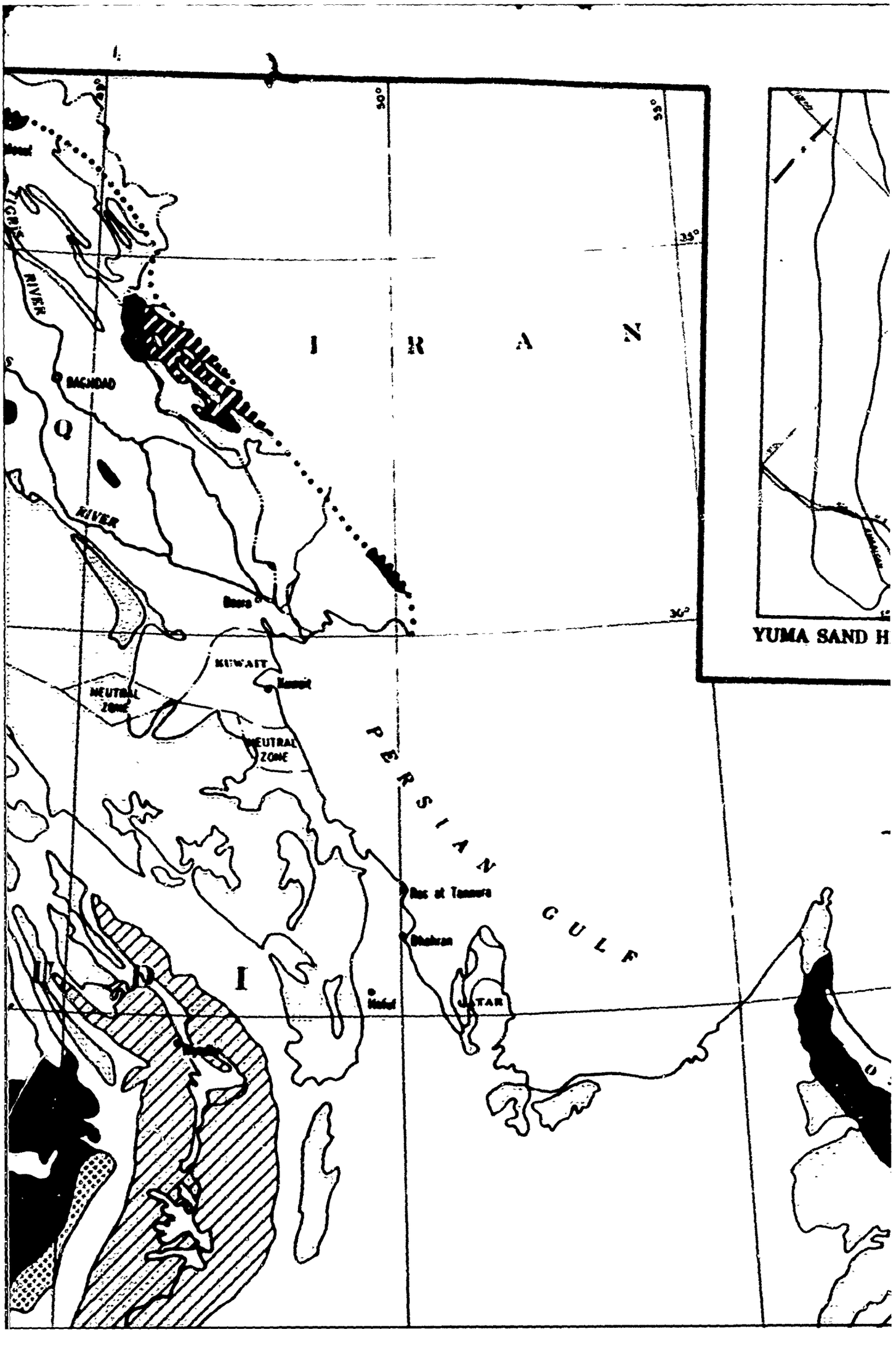
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

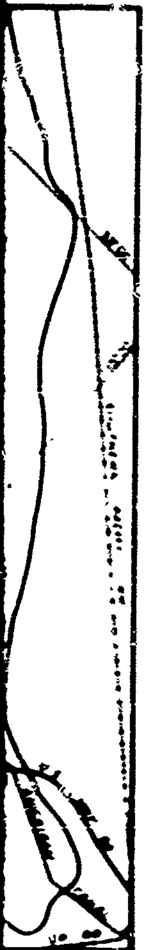
SOIL CONSISTENCY

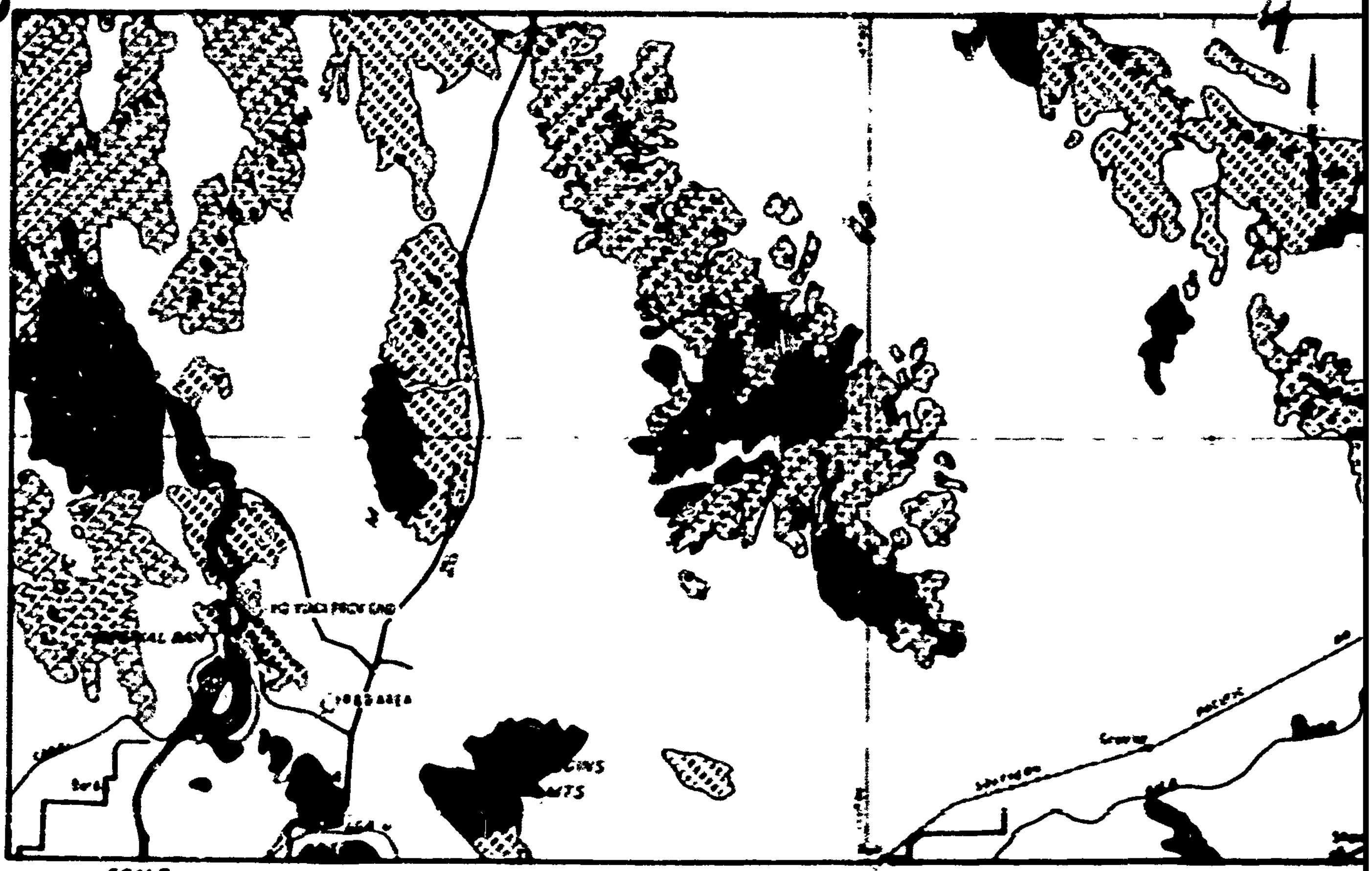
8

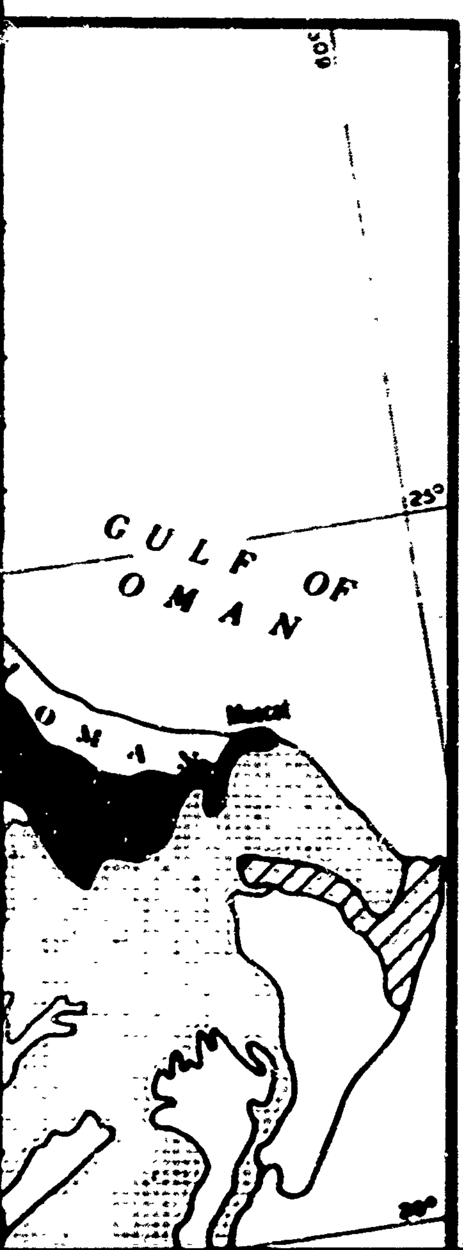
PLATE 7


MEDITERRANEAN SEA
35°
30°
25°
20°
BEIRUT
LEBANON
Tel Aviv
ISRAEL
JERUSALEM
JORDAN
Aqaba
Mosul
TIGRIS RIVER
EUPHRATES RIVER
BAGHDAD
IRAQ
NEUTRAL ZONE
SAUDI ARABIA
RED SEA


IRAN
IRAQ
TIGRIS RIVER
EUPHRATES RIVER
BAGHDAD
KUWAIT
NEUTRAL ZONE
NEUTRAL ZONE
PERSIAN GULF
Ras al Tannura
Bahrain
Hofuf
QATAR
YUMA SAND H







SURFACE ROCK

Mapped in regions where rock is exposed and at shallow depths (i.e. ≤ 10 feet) throughout the remainder of the area. In effect this procedure restricts the mapping of surface rock to areas mapped as 1, 2, or 3 under Soil Type

Areally predominant (70 percent or more) rock type mapped.

1 IGNEOUS (UNDIFFERENTIATED): Rocks formed by solidification or crystallization of a hot fluid mass

2 Intrusive: Igneous rocks, typically crystalline, which have formed by cooling below the surface of the earth (granite, syenite, diorite, etc.)

3 Extrusive (undifferentiated): Igneous rocks which have formed by cooling at the surface of the earth.

3a True extrusive rocks formed by solidification of molten material that poured out on the surface of the earth (e.g. basalt, dacite, etc.)

3b Rocks formed by secondary consolidation of loose deposits of volcanic ejecta (e.g. tuff, agglomerate, etc.)

4 METAMORPHIC (UNDIFFERENTIATED): Rocks formed from original igneous or sedimentary rocks through alterations produced by pressure, heat, or the infiltration of other materials at depths below the surface zones of weathering and cementation. The alterations are sufficiently complete throughout the body of the rock to produce a well-defined new type (gneiss, schist, slate, etc.)

5 SEDIMENTARY (UNDIFFERENTIATED): Rocks formed from material laid down in a more or less finely divided state, as sediment, through the agency of water, wind, or glaciers.

6 Sandstone: A sedimentary rock predominantly composed of sand grains cemented together

7 Limestone: A sedimentary rock consisting essentially of calcium carbonate.

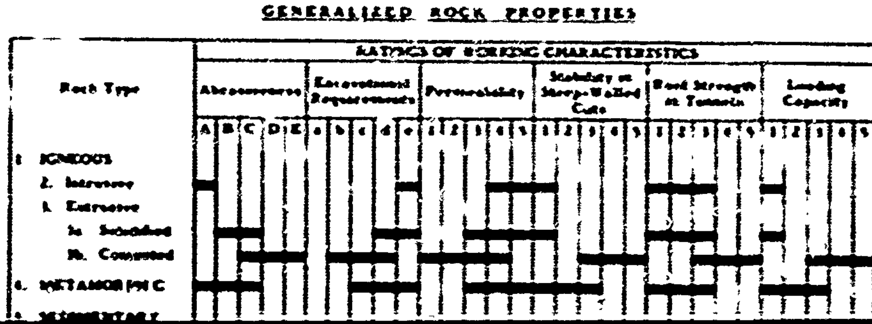
8 Shale: A sedimentary rock in which the constituent particles are predominantly of clay size

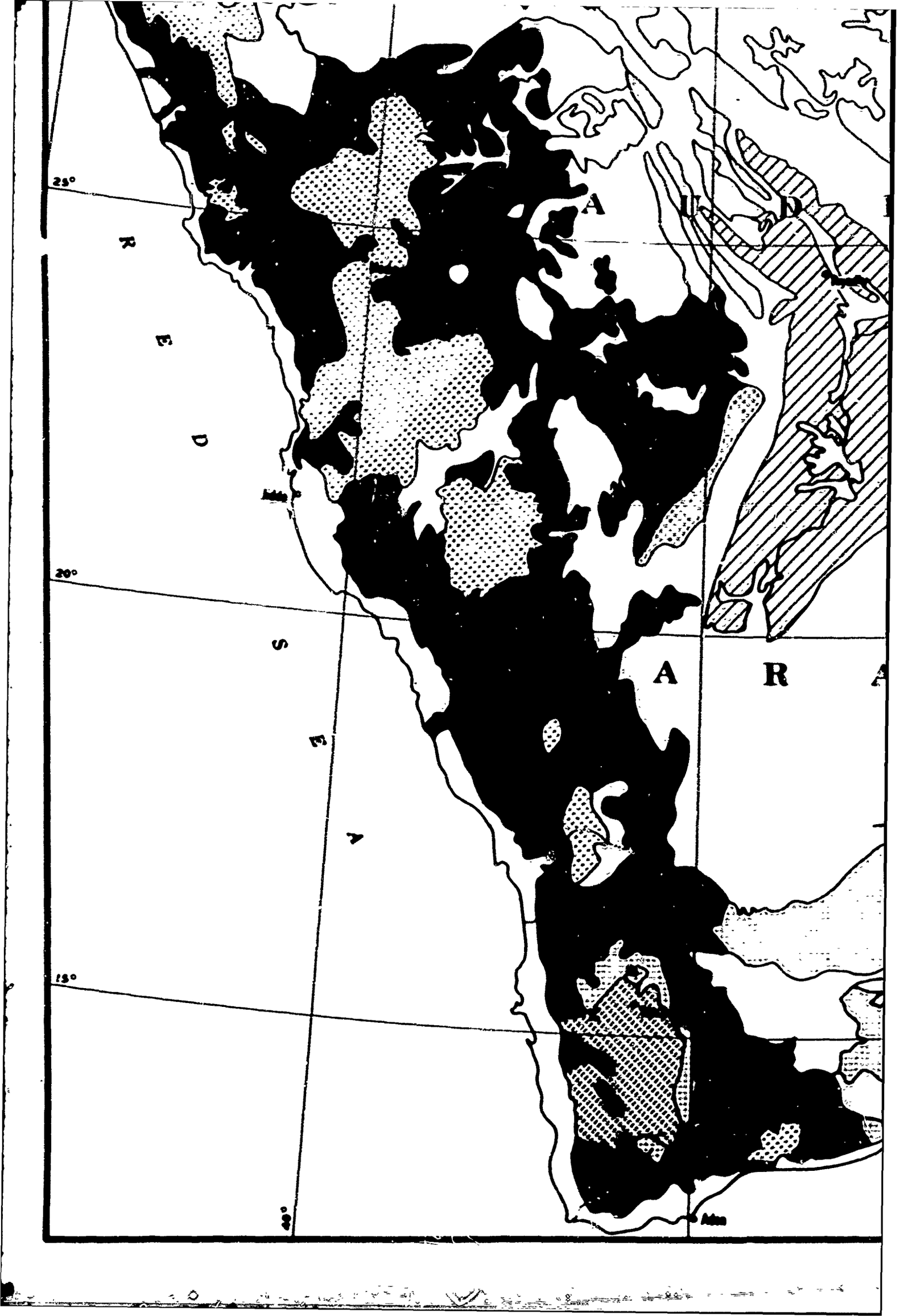
9 Evaporites: A sedimentary rock whose origin is largely due to evaporation and subsequent precipitation of salt from water. (Gypsum, anhydrite, and rock salt are the only evaporites of quantitative importance.)

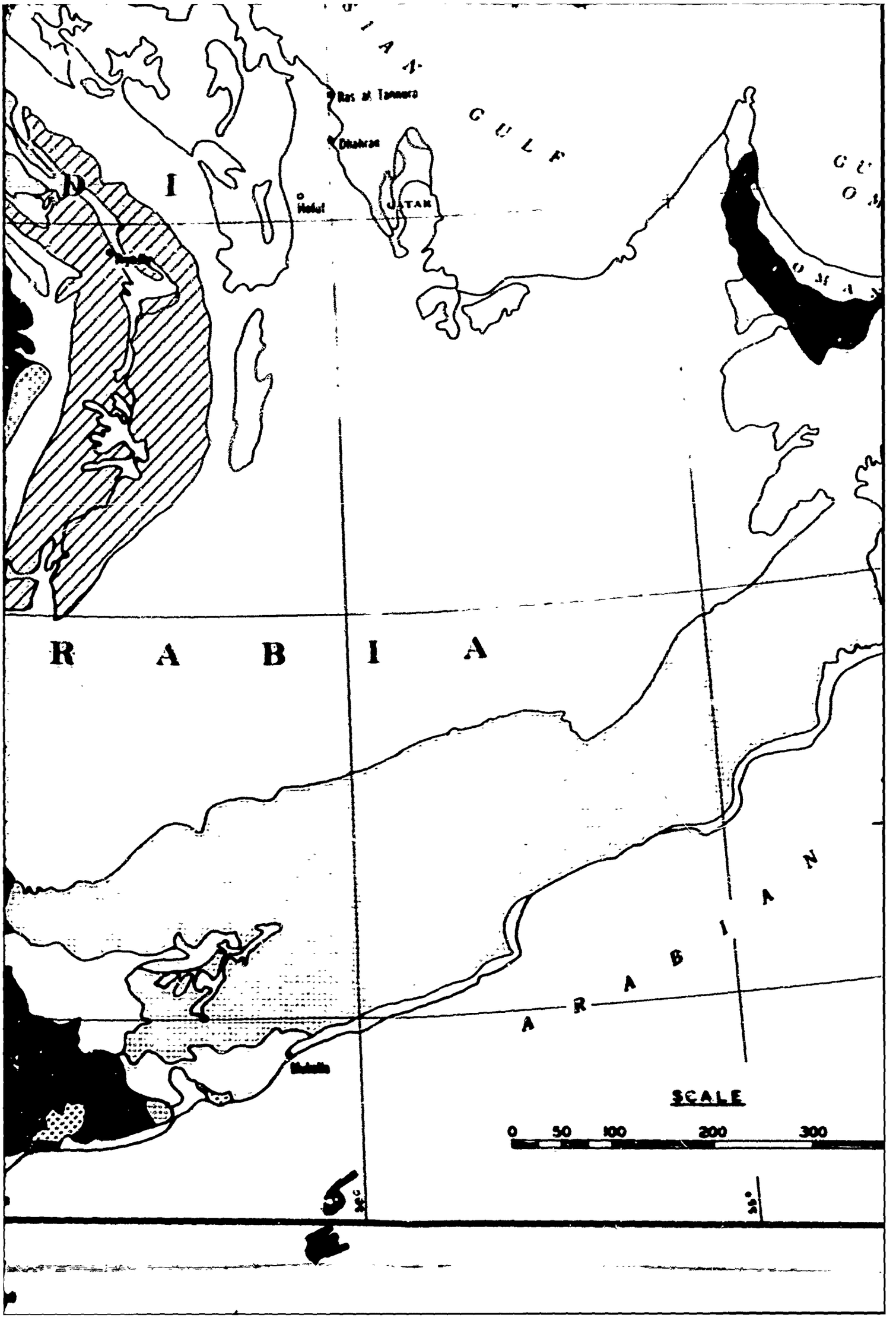
3a/3b ROCK COMPLEXES: Rock complexes are mapped where no areally predominant (70 percent or more) rock type occurs. In such instances, the two most commonly occurring rock types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.

* It should be realized that the scale of mapping precludes delineation, especially in mountainous regions, of many alluvial basins where the thickness of soil cover is much greater than 10 feet.

GENERALIZED ROCK PROPERTIES




25°
20°
15°
40°
R E D S E A
A R A
Mecca
Aden

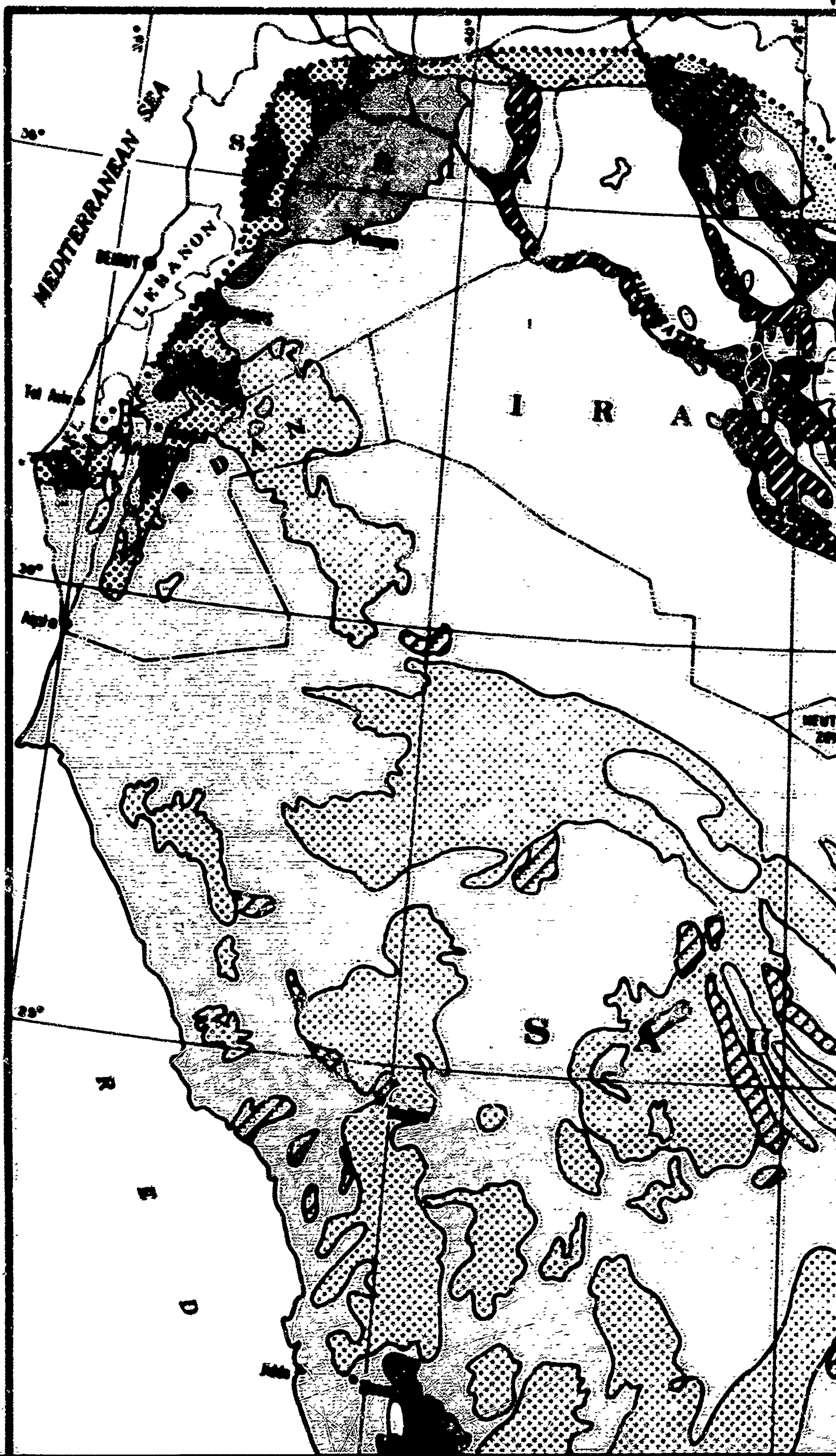

Ras al Tannura
Dhahran
Hofuf
SULTAN
R A B I A
ARABIAN
SCALE
0 50 100 200 300

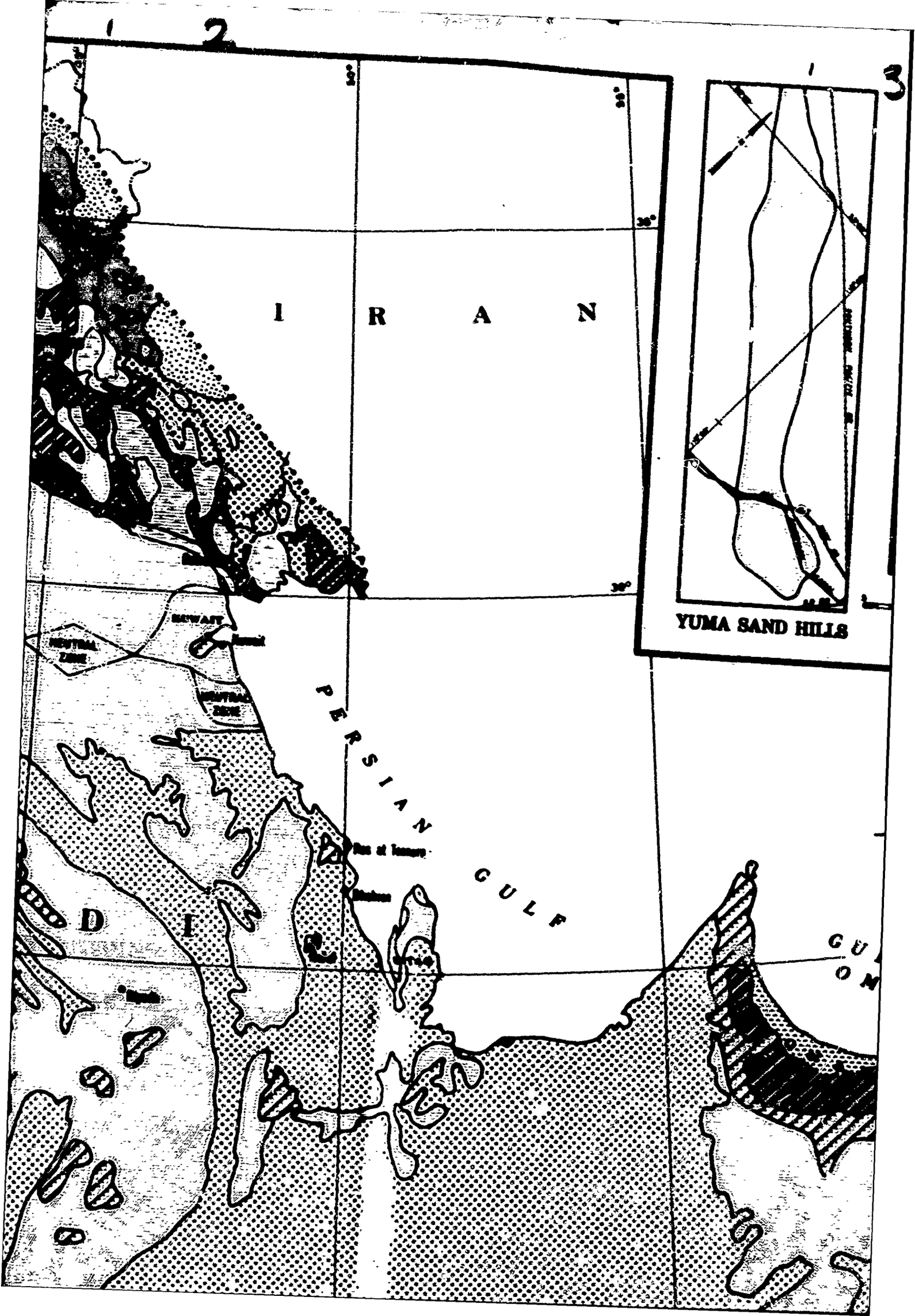
ANALOGS OF YUMA TERRAIN

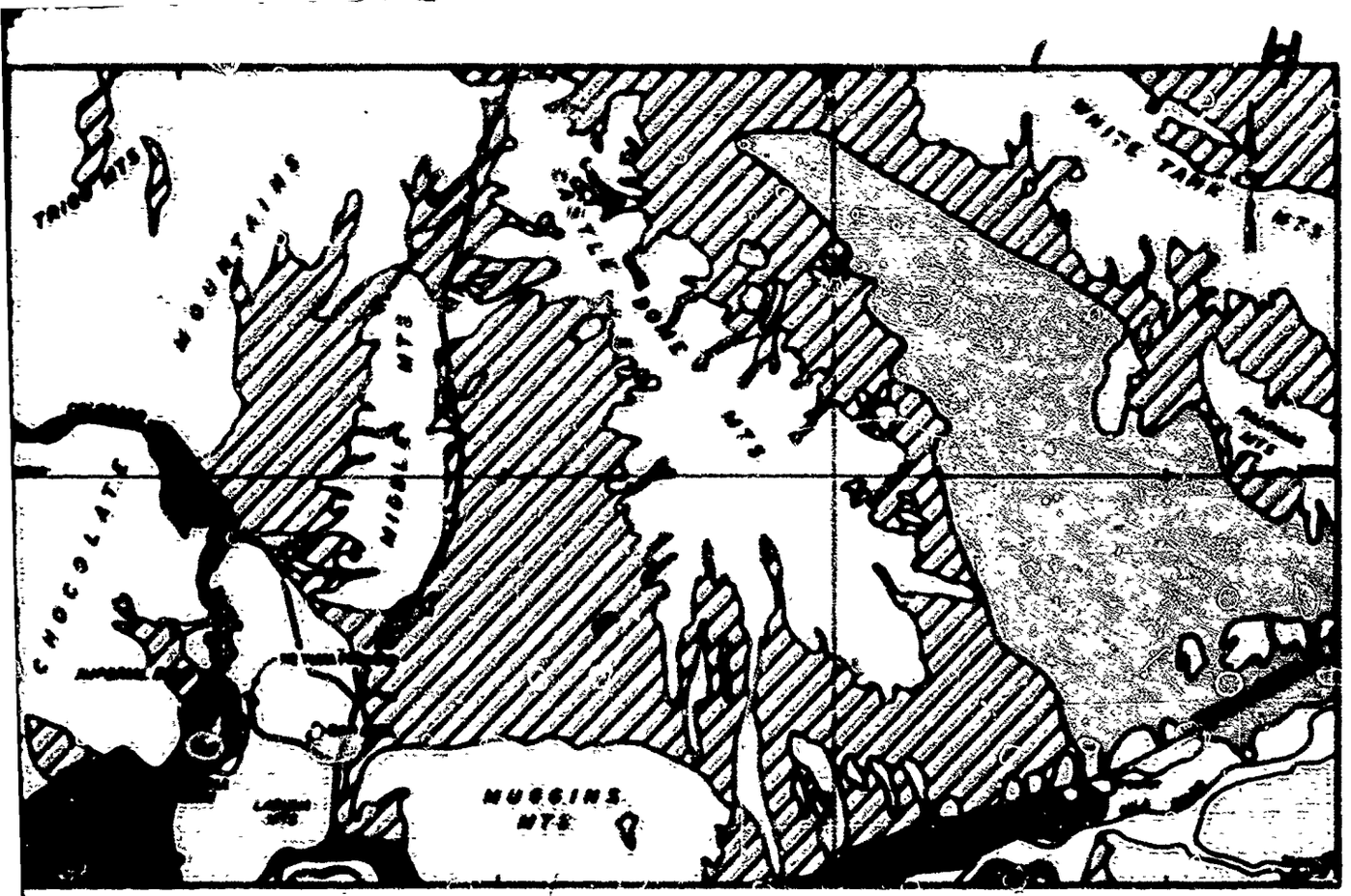
IN THE

MIDDLE EAST DESERT

SURFACE ROCK

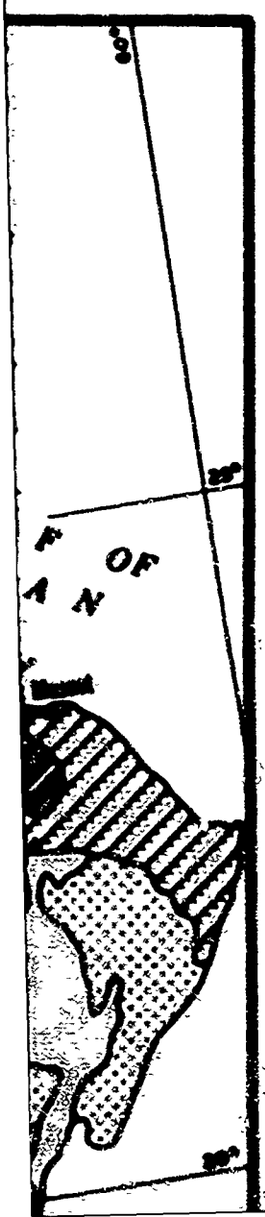

MEDITERRANEAN SEA
LEBANON
BEIRUT
I R A


1
2
3
I R A N
PERSIAN GULF
KUWAIT
NEUTRAL ZONE
NEUTRAL ZONE
YUMA SAND HILLS



SCALE

YUMA PROVING GROUND



VEGETATION

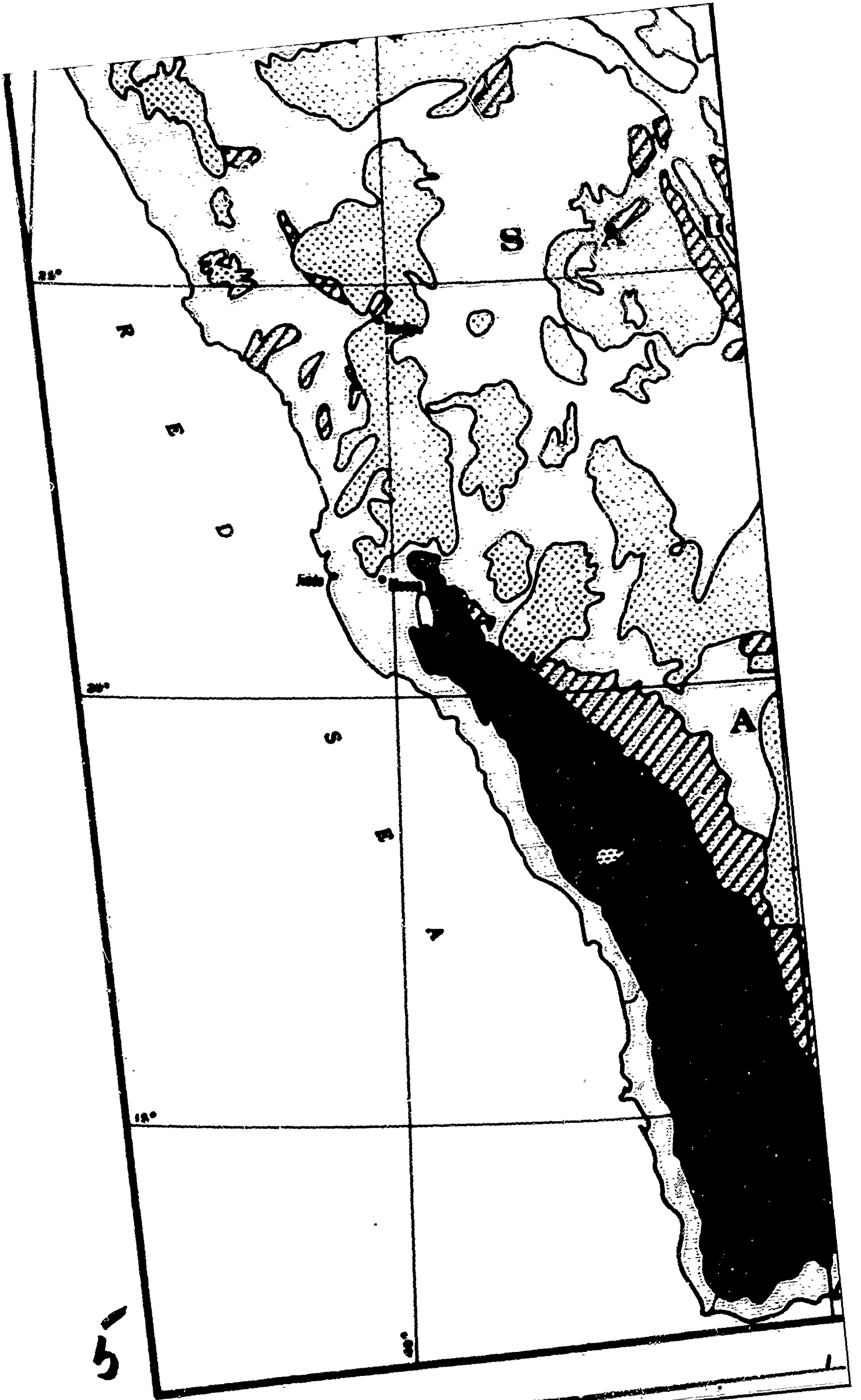
Areally predominant (70 percent or more) vegetation type mapped.

Unit		Description
1	Barren	Devoid or nearly devoid of vegetation.
2	Sparse shrub & grass	Widely spaced shorey shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti in the U. S.)
3	Scattered shrub & grass	Moderate spacing of forms mentioned under unit 2.
4	Scattered shrub and/or scrubby trees	Thin stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
4a	a. With scattered 2nd-story trees	----------
5	Dense shrub and/or scrubby trees	Dense stands of shrubs and scrubby trees, undergrowth (if present) consists of low shrubs, bushes, and grasses.
5a	a. With scattered 2nd-story trees	----------
5b	b. With grass-herb cultivation	Orchard trees with grass-herb cultivation forming the 1st story.
6	Palms with or without grass-herb cultivation	Dense palm groves, 1st-story grass-herb cultivation may or may not be present.
7	Steppe	Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.
8	Steppe-savanna	High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass averages 3-5 ft.
9	Grass-herb cultivation	Cultivated plots of grains, vegetables, etc.
10	Marsh	Dense growth of grasses, sedges, etc.
5/6	VEGETATION COMPLEXES	Vegetation complexes are mapped where no areally predominant (70 percent or more) vegetation type occurs. In such instances, the two most commonly occurring types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.
	palms	

VEGETATION

Supplementary Data

Unit	Ground Cover	Canopy Cover		Stratum		Stratum		Trunk Diam		Crown Diam	
		Both	Tree	Ht	Dens	Ht	Dens	Ht	Dens	Ht	Dens


S
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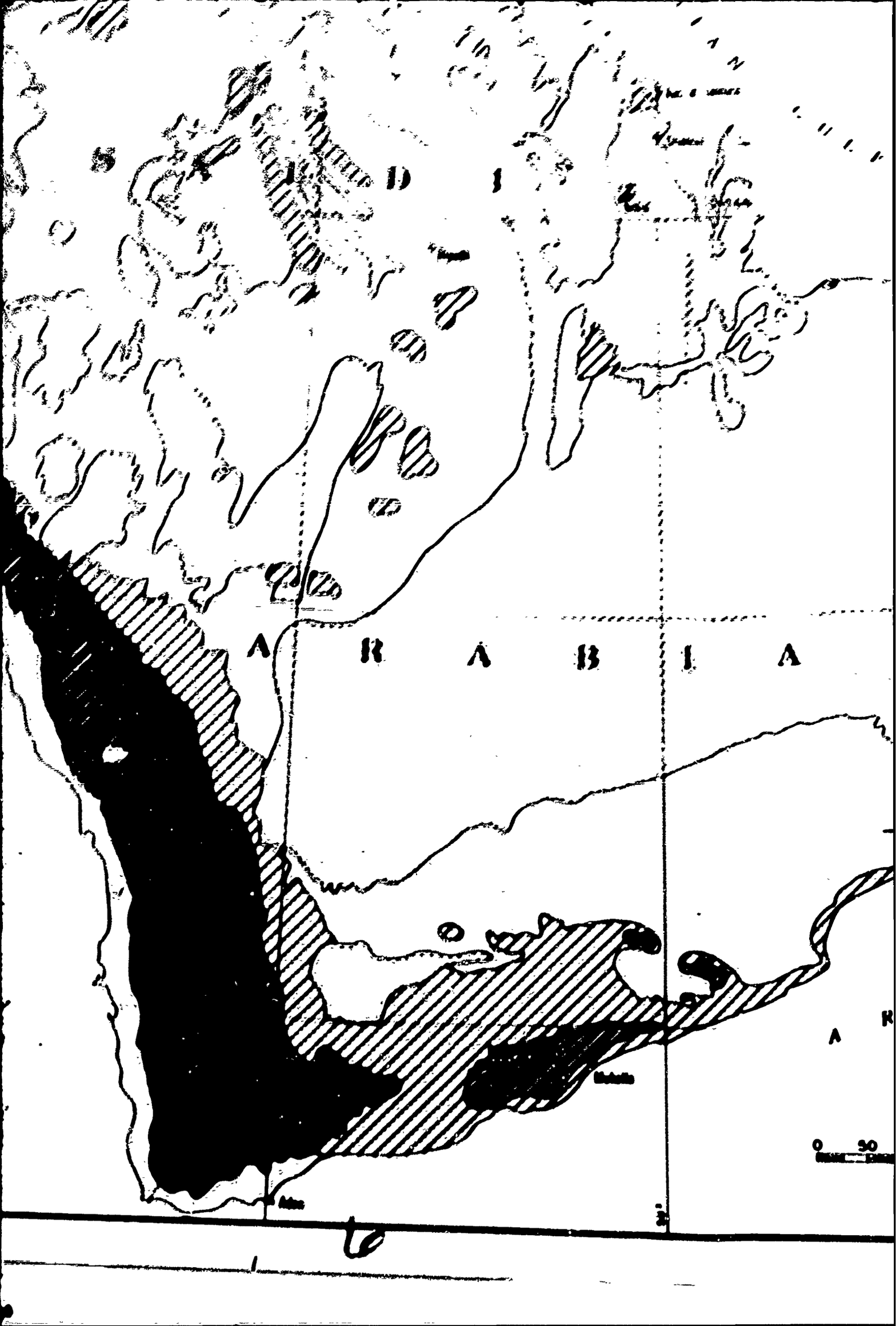
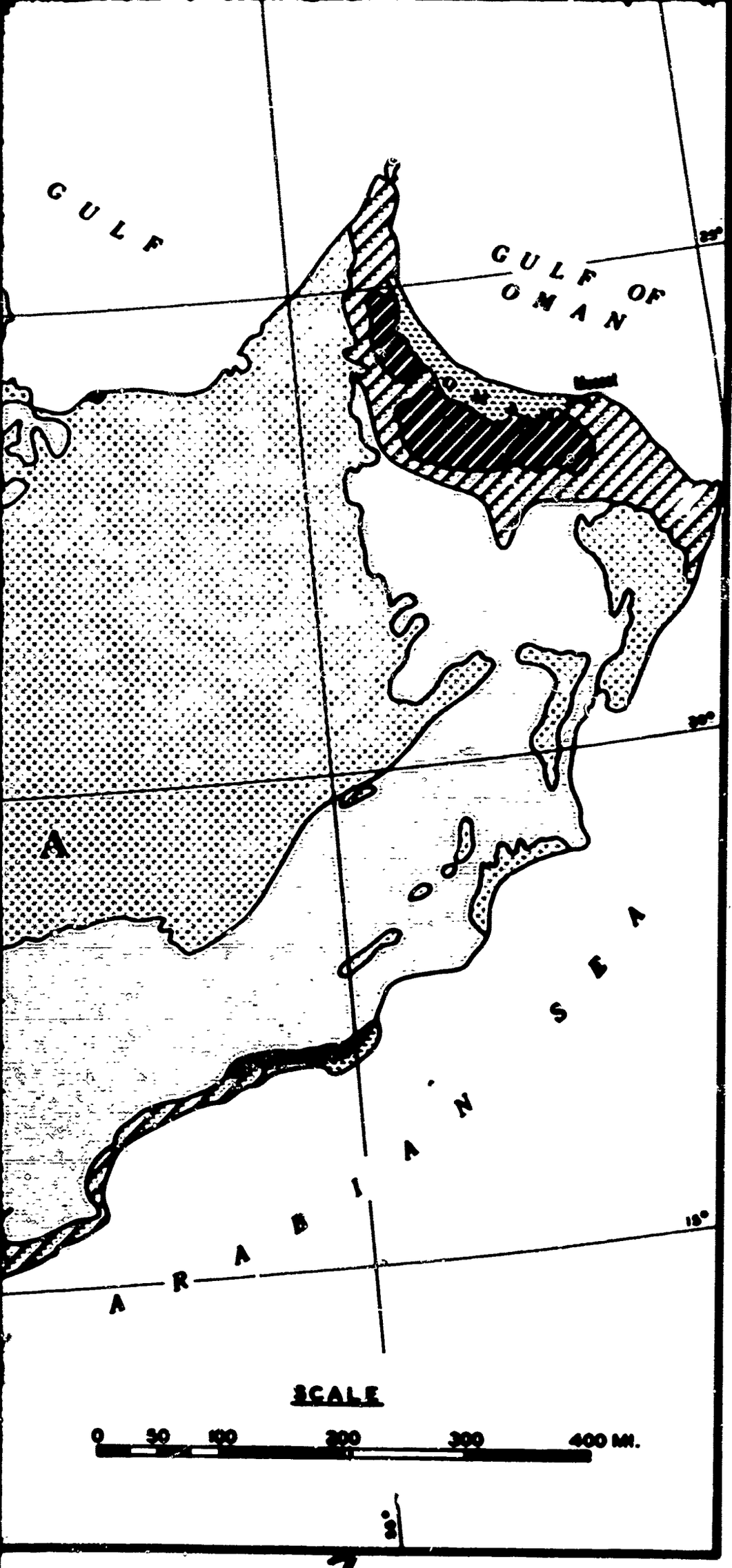
A
A
28°
24°
20°


A R A B I A
0 50



Areally predominant (70 p

	Unit
1	Barren
2	Sparse shrub & grass
3	Scattered shrub & grass
4	Scattered shrub and/or scrubby trees
4a	a. With scattered 3rd-story trees
5	Dense shrub and/or scrubby trees
5a	a. With scattered 3rd-story trees
5b	b. With grain-herb cultivation
6	Palms with or without grain-herb cultivation
7	Steppe
8	Steppe-savanna
9	Grain-herb cultivation
10	Marsh
1/4	VEGETATION COMPLEXES
	Palms

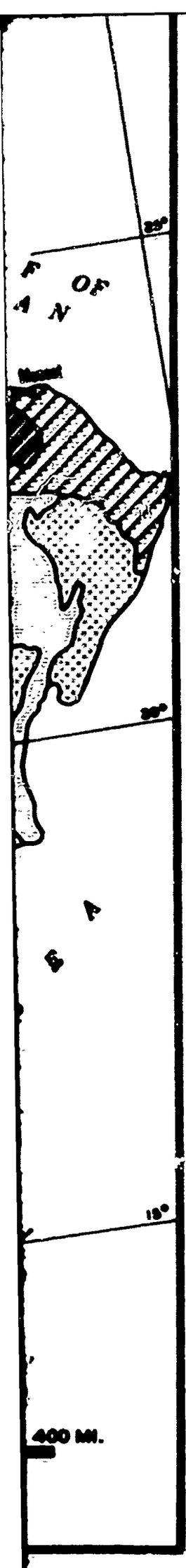
Unit	Ground Cover %	Canopy Cover 2nd* Story %
1. Barren	<1	†
2. Sparse shrub & grass	1-5	†
3. Scattered shrub & grass	5-25	0-5
4. Scattered shrub and/or scrubby trees	50-90	<50
With scattered 3rd-story trees	50-90	<05
5. Dense shrub and/or scrubby trees	80-100	>50
a. With scattered 3rd-story trees	80-100	>50
b. With grain-herb cultivation	90-100	>50
6. Palms with or without grain-herb cultivation	75-100	†
7. Steppe	50-100	†
8. Steppe-savanna	90-100	5-10
9. Grain-herb cultivation	90-100	†
10. Marsh	80-100	†

* Vegetation strata are distinguished on the basis of height
5 to 25 ft. 3rd story, from 25 to 70 ft.
† Indicates factor is unimportant or not applicable within

ANALOGS O

MIDDLE

VEG



VEGETATION

Actually predominant (50 percent or more) vegetation type mapped.

Unit		Description
1	Barren	Ground or areas devoid of vegetation.
2	Sparse shrub & grass	Widely spaced thorny shrubs, bushes, low scrubby trees, herbs, or clumps and open stands of coarse grass. (Also includes cacti on the U. S.)
3	Scattered shrub & grass	Moderate spacing of forms enumerated under unit 2.
4	Scattered shrub and/or scrubby trees	Thin stands of shrubs and scrubby trees, undergrowth (5 percent) consists of low shrubs, bushes, and grasses.
4a	a. With scattered 3rd-story trees	----------
5	Dense shrub and/or scrubby trees	Dense stands of shrubs and scrubby trees, undergrowth (5 percent) consists of low shrubs, bushes, and grasses.
5a	a. With scattered 3rd-story trees	----------
5b	b. With grain-herb cultivation	Orchard areas with grain-herb cultivation forming the 1st story.
6	Palms with or without grain-herb cultivation	Dense palm groves. 1st-story grain-herb cultivation may or may not be present.
7	Steppe	Low grass cover, may or may not include scattered low scrubby trees and shrubs. Height of grass ranges from a few in. to 2 ft.
8	Steppe-savanna	High continuous grass cover, includes scattered scrubby trees and shrubs. Height of grass averages 3-5 ft.
9	Grain-herb cultivation	Cultivated plots of grains, vegetables, etc.
10	Marsh	Dense growth of grasses, sedges, etc.
3/6	VEGETATION COMPLEXES	Vegetation complexes are mapped where no actually predominant (50 percent or more) vegetation type occurs. In such instances, the two most commonly occurring types are mapped, the predominant is shown as the numerator, the subordinate as the denominator in the fractional pattern.
	Palms	

VEGETATION

(Supplementary Data)

Unit	Ground Cover %	Canopy Cover		Spacing		Height		Trunk Diam		Crown Diam	
		2nd* Story %	3rd Story %	2nd Story ft	3rd Story ft	2nd Story ft	3rd Story ft	2nd Story in.	3rd Story in.	2nd Story ft	3rd Story ft
1. Barren	<1	†	†	†	†	†	†	†	†	†	†
2. Sparse shrub & grass	1-5	†	†	†	†	†	†	†	†	†	†
3. Scattered shrub & grass	5-25	0-5	†	much >12	†	6-10	†	2-5	†	5-10	†
4. Scattered shrub and/or scrubby trees	50-90	<50	†	>12	†	6-25	†	2-12	†	5-25	†
With scattered 3rd-story trees	50-90	<05	5-25	>12	>12	6-25	25-50	2-12	12-20	5-25	25-60
5. Dense shrub and/or scrubby trees	80-100	>50	†	<12	†	6-25	†	2-12	†	5-25	†
a. With scattered 3rd-story trees	80-100	>50	5-25	<12	>12	6-25	25-50	2-12	12-20	5-25	25-60
b. With grain-herb cultivation	90-100	>50	†	>12	†	10-20	†	5-10	†	10-20	†
6. Palms with or without grain-herb cultivation	75-100	†	50-75	†	>12	†	60-80	†	12-20	†	20-30
7. Steppe	50-100	†	†	†	†	†	†	†	†	†	†
8. Steppe-savanna	90-100	5-10	†	much >12	†	15-25	†	7-12	†	15-25	†
9. Grain-herb cultivation	90-100	†	†	†	†	†	†	†	†	†	†
10. Marsh	80-100	†	†	†	†	†	†	†	†	†	†

* Vegetation strata are distinguished on the basis of height: 1st-story vegetation ranges from 0 to 6 ft in height, 2nd story, from 6 to 25 ft; 3rd story, from 25 to 70 ft.

† Indicates factor is unimportant or not applicable within the vegetation unit.

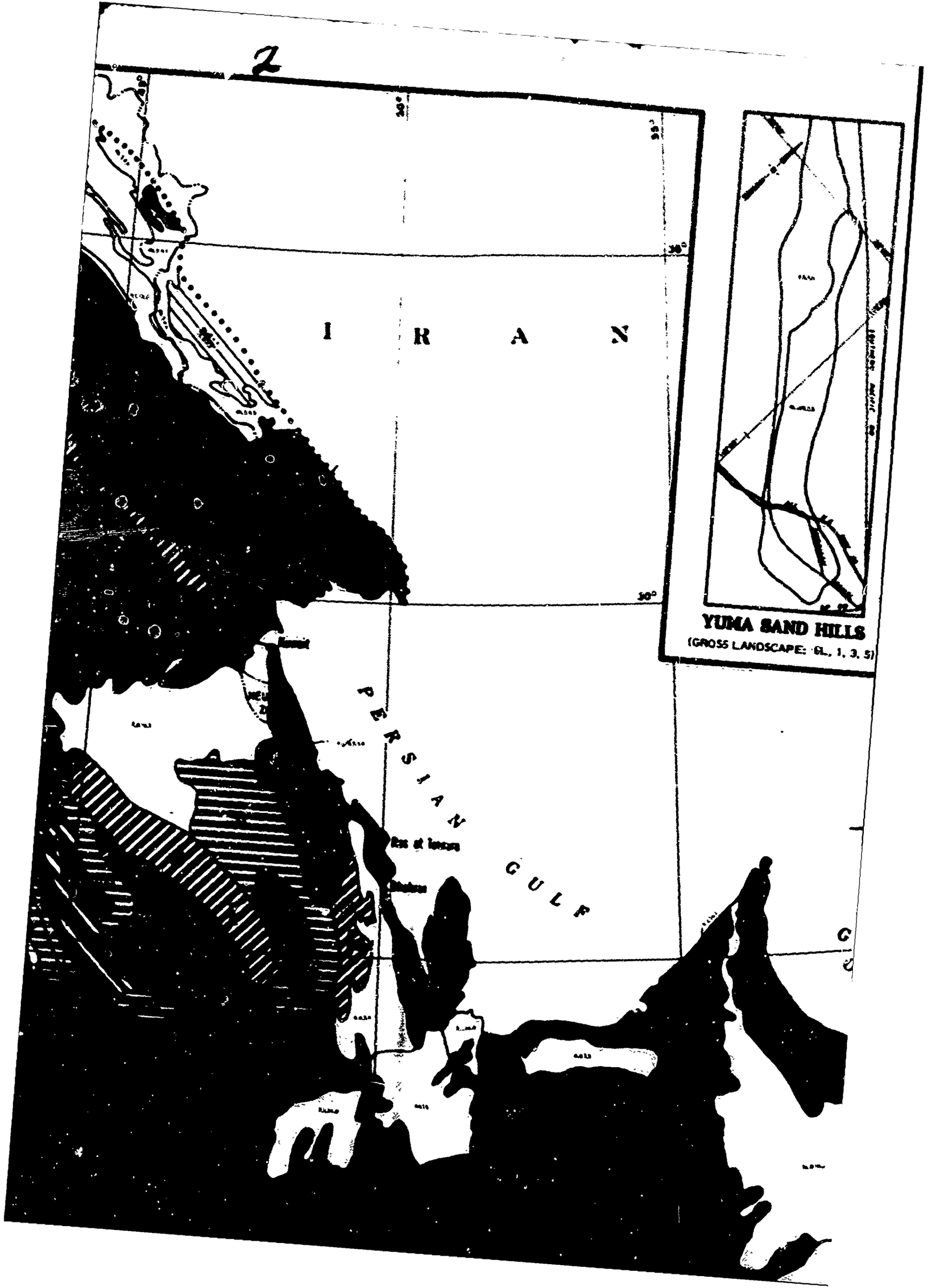
ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

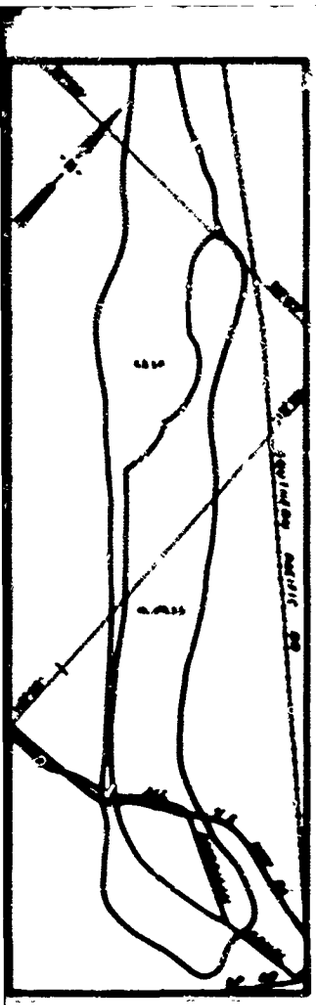
8

VEGETATION

PLATE 9

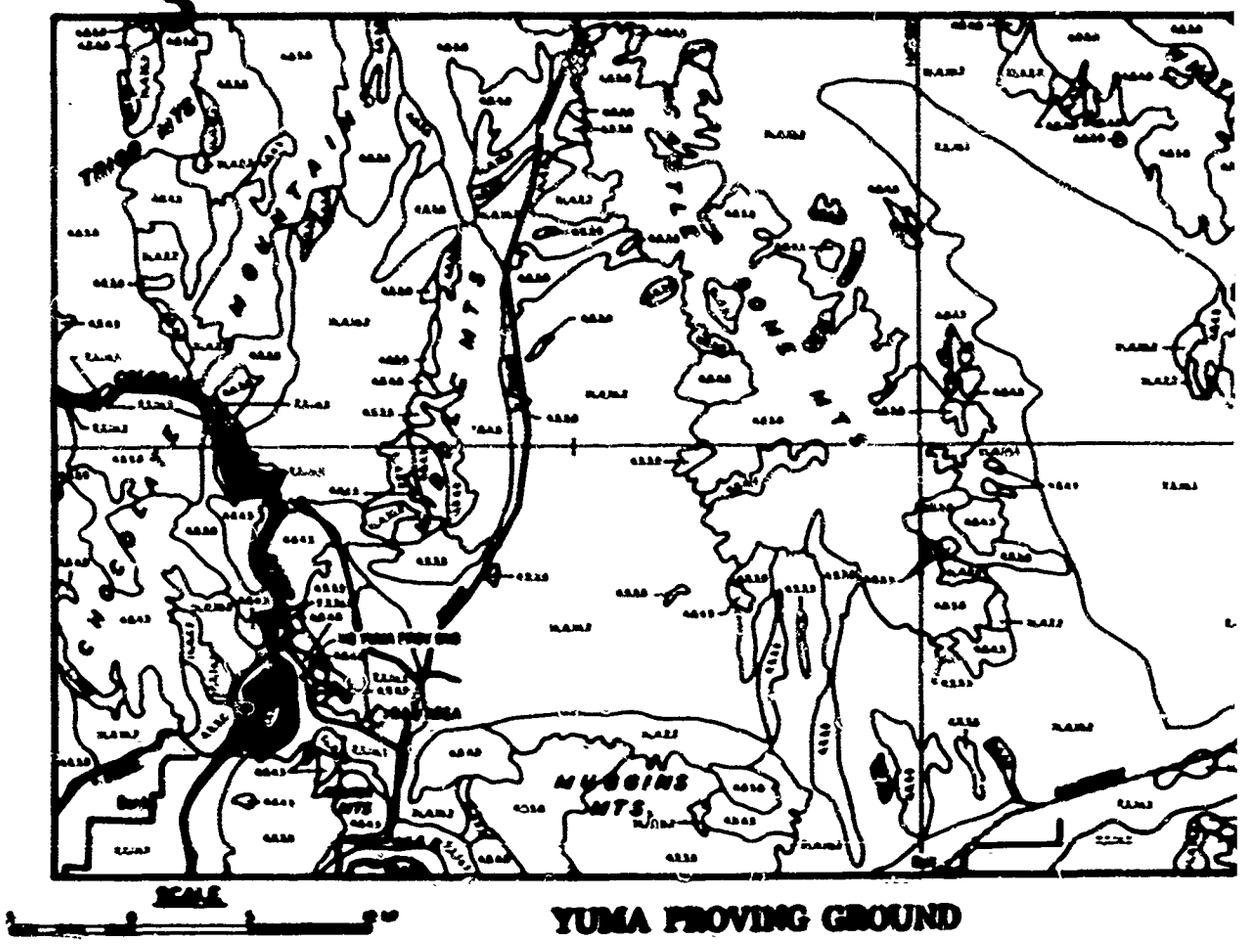
MEDITERRANEAN SEA
ALEPPO
BEIRUT
LEBANON
Tigris
35°
30°
29°
A
R
D


2
I R A N
PERSIAN GULF
YUMA SAND HILLS
(GROSS LANDSCAPE: 0, 1, 3, 5)



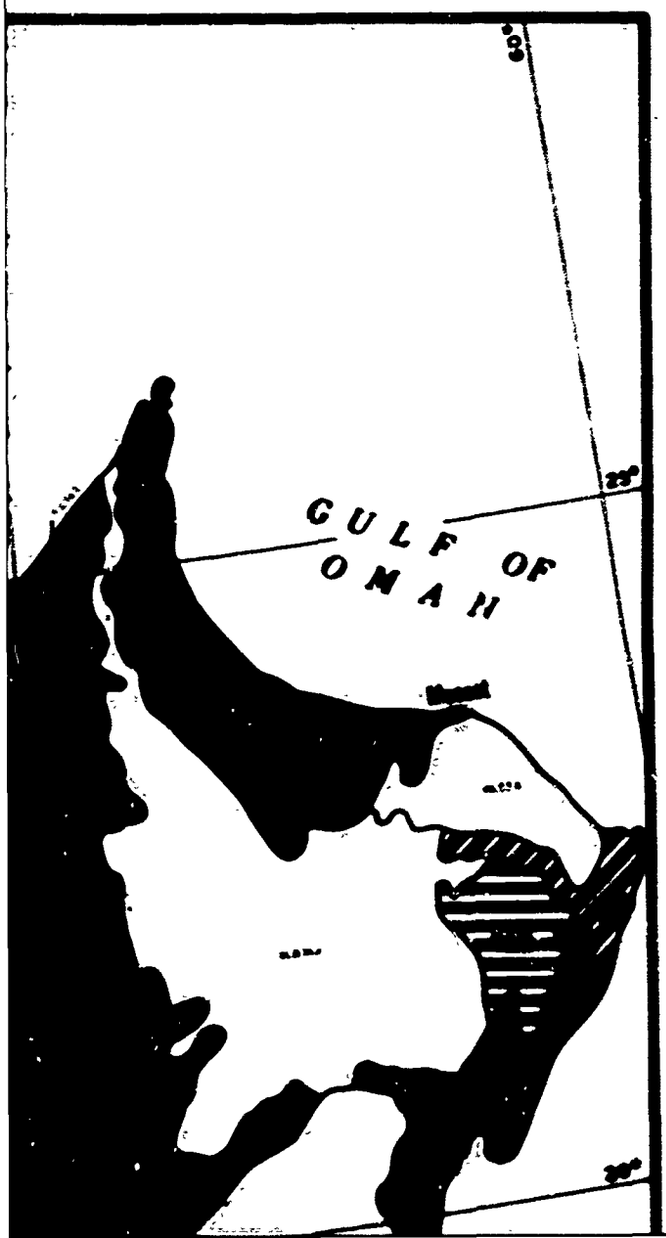
YUMA SAND HILLS

(GROSS LANDSCAPE: 6L, 1, 3, 5)



YUMA PROVING GROUND

(GROSS LANDSCAPE: 5L //, 1, 5, 7)



GEOMETRY OR FORM ANALOGS

LEGEND

Each landscape type is described by a series or an array of four symbols indicating mapping units of PLAN-PROFILE (6L SLOPE OCCURRENCE (1), SLOPE (3), and RELIEF (5). Mapping units of these four factors are always designated in this order.

Landscapes in the Middle East are also are compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in light- and boldface type to indicate the maximum degree of analogy with Yuma, the analogy decreasing as the number of lightface units increases. Units shown in boldface type are not found at Yuma in combination with the remaining units of the array. Units in lightface type indicate the maximum number of units found in the closest corresponding array on the Yuma map.*

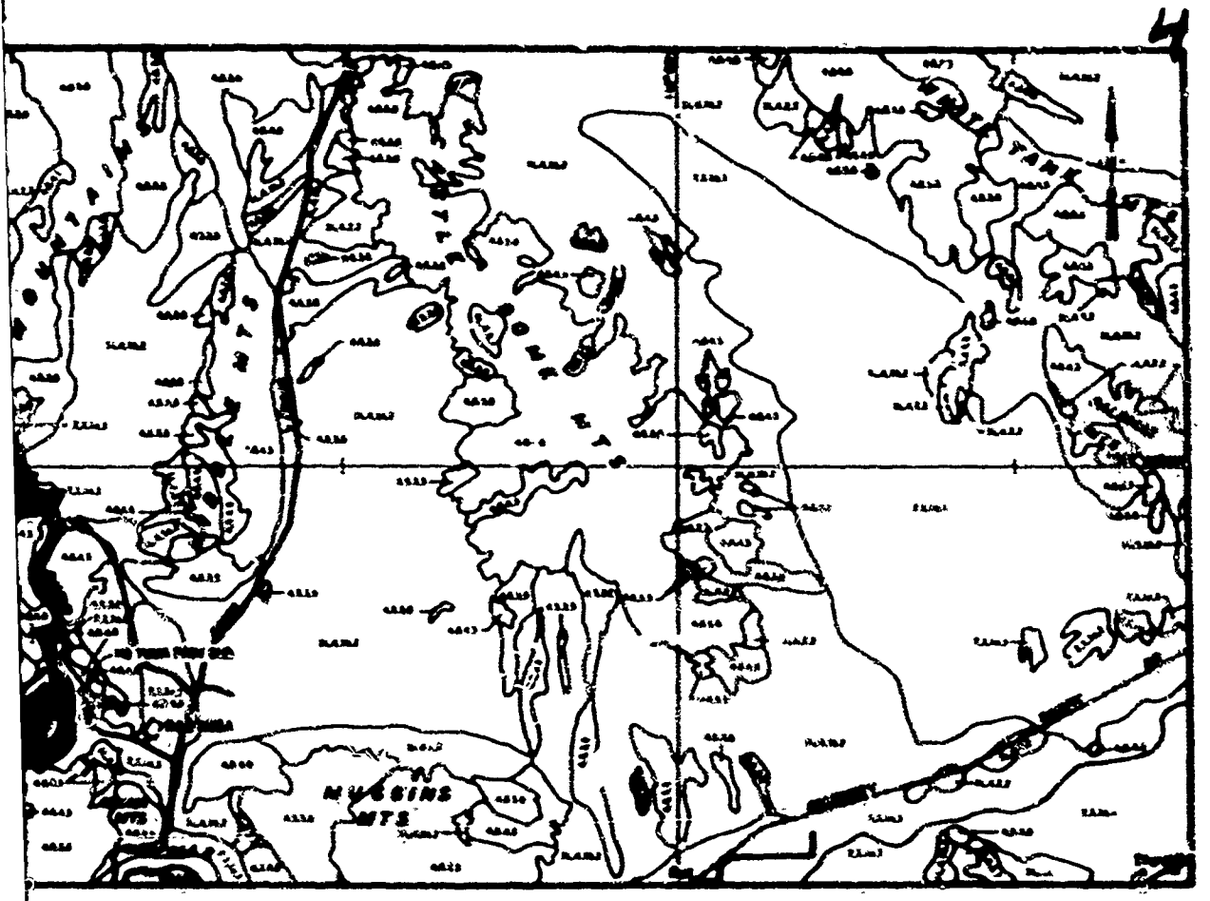
Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

Gross-Component Complex. The gross landscape is compared only with other gross landscapes.

4	Highly Analogous	The identical landscape is found at Yuma.
3	Moderately Analogous	Three units of the array are found in an array occurring at Yuma.
1,2	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicates the degree of analogy of the areally predominant landscape type.



YUMA PROVING GROUND

(GROSS LANDSCAPE: SL //, 1, 5, 7)

GEOMETRIC OR EDPM ANALYSIS

LEGEND

0000 Each landscape type is simulated on a canvas or an array of four symbols indicating mapping units of PLAN-PROFILE (0), SLOPE OCCURRENCE (0), SLOPE (0), and RELIEF (0). Mapping units of these four factors are always designated in this order.

0000 Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in light- and boldface type to indicate the maximum degree of analogy with Yuma, the analogy increasing as the number of lightface units increases. Units shown in boldface type are not found at Yuma in combination with the remaining units of the array. Units in lightface type indicate the maximum number of units found in the closest-corresponding array on the Yuma map.*

0/0 land Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

0000 water Gross-Component Complex. The gross landscape is compared only with other gross landscapes.

1	Highly Analogous	The identical landscape is found at Yuma.
1	Moderately Analogous	Three units of the array are found in an array occurring at Yuma.
1.5	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicating the degree of analogy of the areally predominant


A
E
S
A
D
E
R


N
Ras al Hamra
Dhahran
GULF
A
A
R
A
0 50 100

GEOMETRY OR FORM ANAL

LEGEND

Highly Analogous

Moderately Analogous

Slightly Analogous

Not Analogous

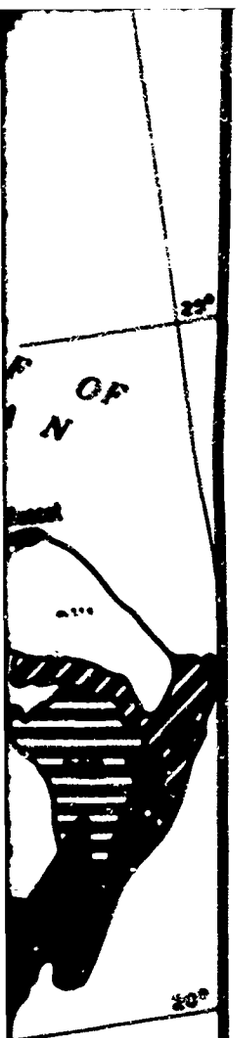
LANDSCAPE COMPLEXES

ANALOGS OF YUMA

IN THE

MIDDLE EAST DE

GEOMETRY AN



GEOMETRIC OR FORM ANALOGS

LEGEND

xxxx Each landscape type is symbolized by a picture or an array of four symbols each coding mapping units of PLAN-PROFILE (1), SLOPE OCCURRENCE (2), SLOPE (3), and RELIEF (4). Mapping units of these four factors are always designated in this order.

xxxx Landscapes in the Middle East are always compared with Yuma landscapes and not vice versa. The array of symbols in the Middle East is shown in light- and boldface type to indicate the maximum degree of analogy with Yuma, the analogy increasing as the number of lightface units increases. Units shown in boldface type are not found at Yuma in combination with the remaining units of the array. Units in lightface type indicate the maximum number of units found in the closest corresponding array on the Yuma map.*

Areal Complex. The areally predominant landscape is the numerator of the complex, the subordinate the denominator.

Gross-Component Complex. The gross landscape is compared only with other gross landscapes.

4	Highly Analogous	The identical landscape is found at Yuma.
3	Moderately Analogous	Three units of the array are found in an array containing at Yuma.
1-2	Slightly Analogous	One or two units of the array are found in an array at Yuma.
0	Not Analogous	No unit of the array is found at Yuma.

LANDSCAPE COMPLEXES

Indicates the degree of analogy of the areally predominant landscape type.

Indicates the degree of analogy of the areally subordinate landscape type.

Indicates the degree of analogy of the gross landscape.

Indicates the degree of analogy of the restrictive landscape of component kind.

Indicates the degree of analogy of the gross landscape.

Indicates the degree of analogy of the restrictive landscape of component kind.

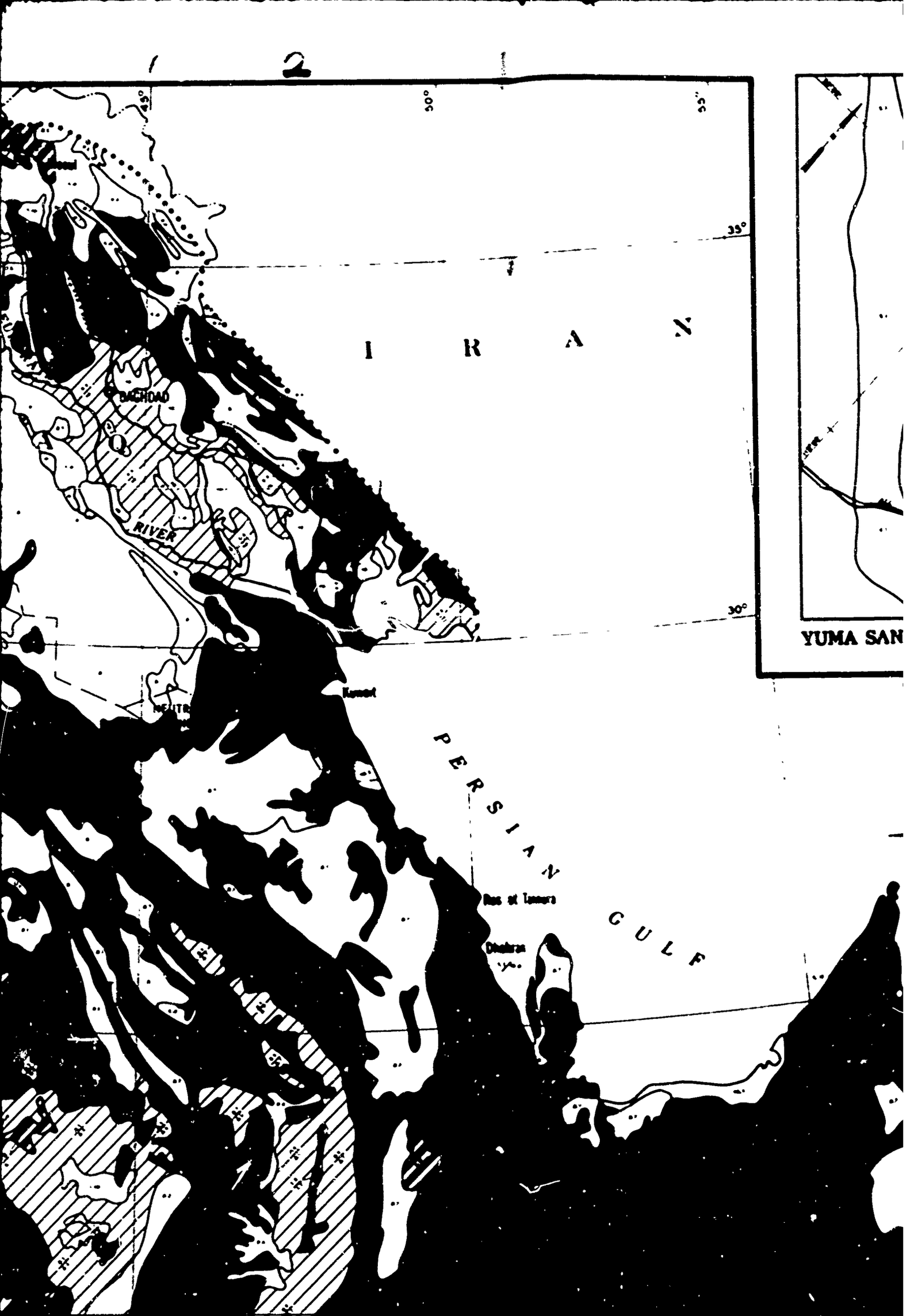
* In a particular array it may be possible to choose different sets of light- or boldface units to indicate the maximum degree of analogy. In such instances units are compared in the order given in the array. For example, the Middle East array [illegible] was compared with the Yuma array [illegible] rather than with Yuma [illegible]. A comparison with the latter would have resulted in the symbolization [illegible].

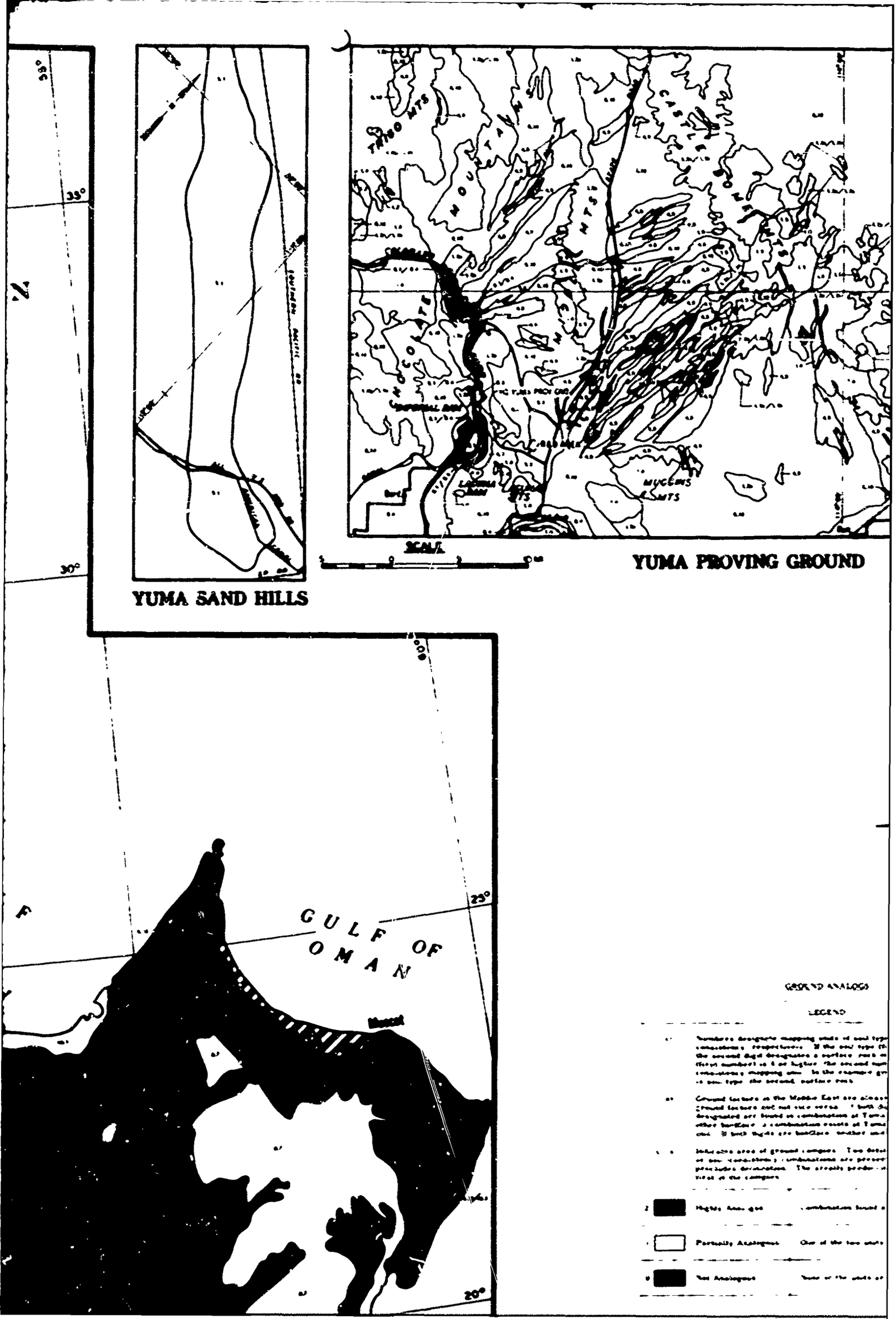
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT
GEOMETRY ANALOGS

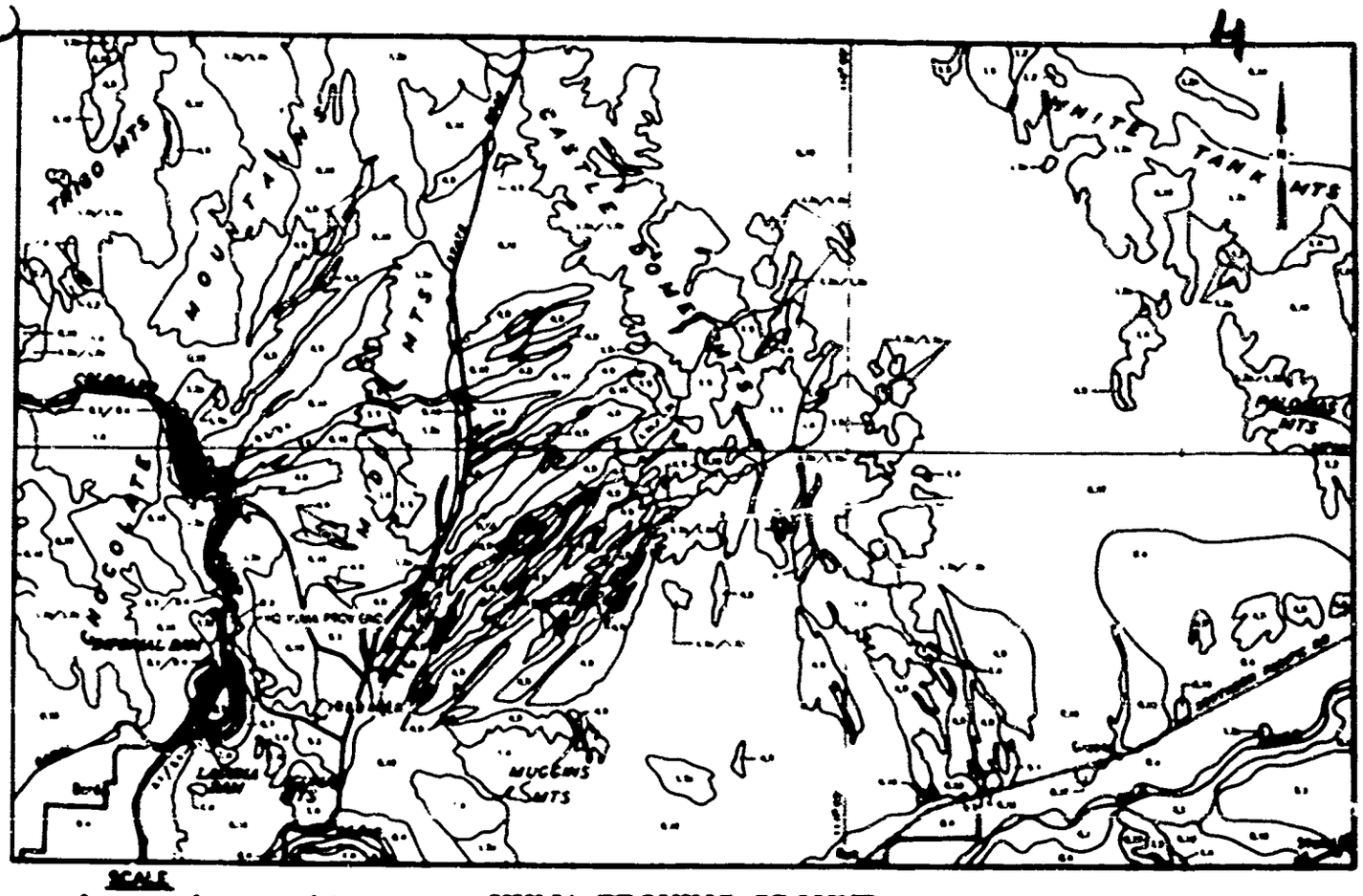
8

PLATE 10

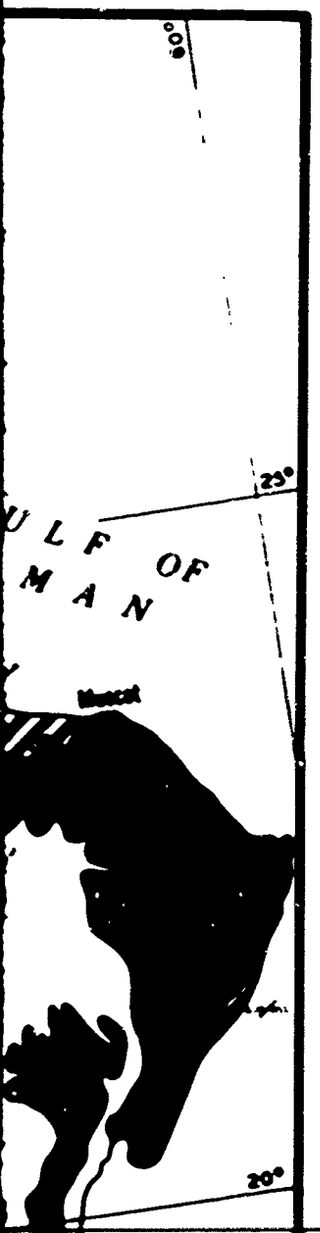
MEDITERRANEAN SEA
35°
30°
25°
BEIRUT
LEBANON
Tel Aviv
JORDAN
Amman
Palmyra
BAGHDAD
RIVER
Jeddah


I R A N
BAGHDAD
RIVER
Kuwait
PERSIAN GULF
YUMA SAN


YUMA SAND HILLS
YUMA PROVING GROUND
GULF OF OMAN
35°
30°
25°
20°
90°
SCALE
GROUND ANALOGS
LEGEND



YUMA PROVING GROUND



GROUND ANALOGS

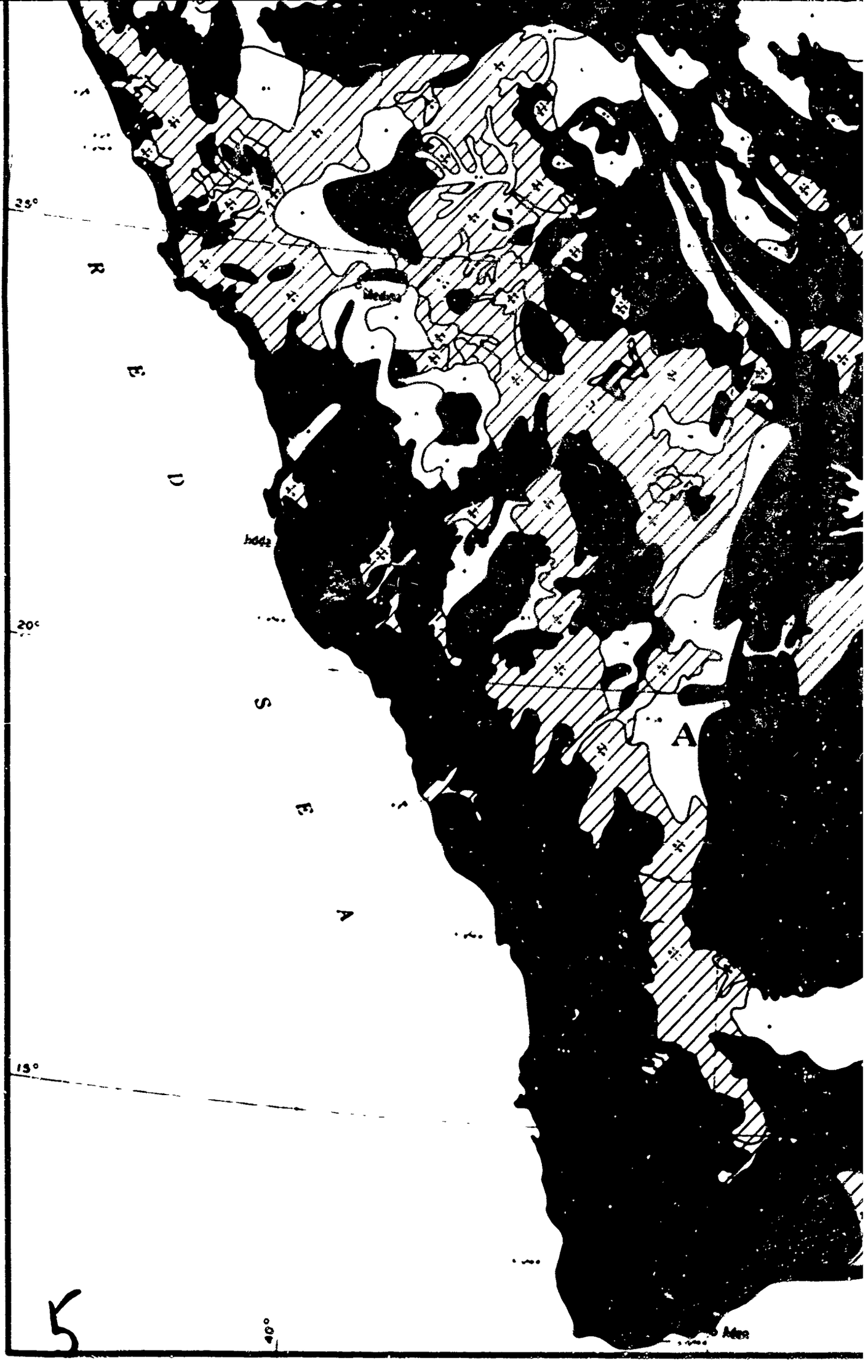
LEGEND

* Numbers designate mapping units of soil type and surface rock or soil conditions, respectively. If the soil type (first number) is 1, 2, or 3, the second digit designates a surface-rock mapping unit; if the soil type (first number) is 4 or higher, the second number designates a soil conditions mapping unit. In the example given, e.g., 3 7, the first digit is soil type, the second, surface rock.

** Ground factors in the Middle East are always compared with Yuma ground factors and not vice versa. If both digits are nonblank, the units designated are found in combination at Yuma. If one is nonblank and the other blank, a combination exists at Yuma containing the nonblank unit. If both digits are blank, neither unit is found at Yuma.

* - * Indicates area of ground complex. Two definable soil type-surface rock or soil conditions combinations are present, but the scale mapping precludes delineation. The area is predominant ground factor appears first in the complex.

1	Highly Analogous	combinations found at Yuma
2	Partially Analogous	One of the two units is found at Yuma
3	Not Analogous	None of the units are found at Yuma


25°
20°
15°
R
E
D
S
E
A
S
A
Medina
Jeddah
Aden


GULF
GULF OF OMAN
Muscat
ARABIAN SEA
Mukalla
SCALE
0 50 100 200 300 400 MI.

ANALOGS OF YUMA TERRAIN

IN THE

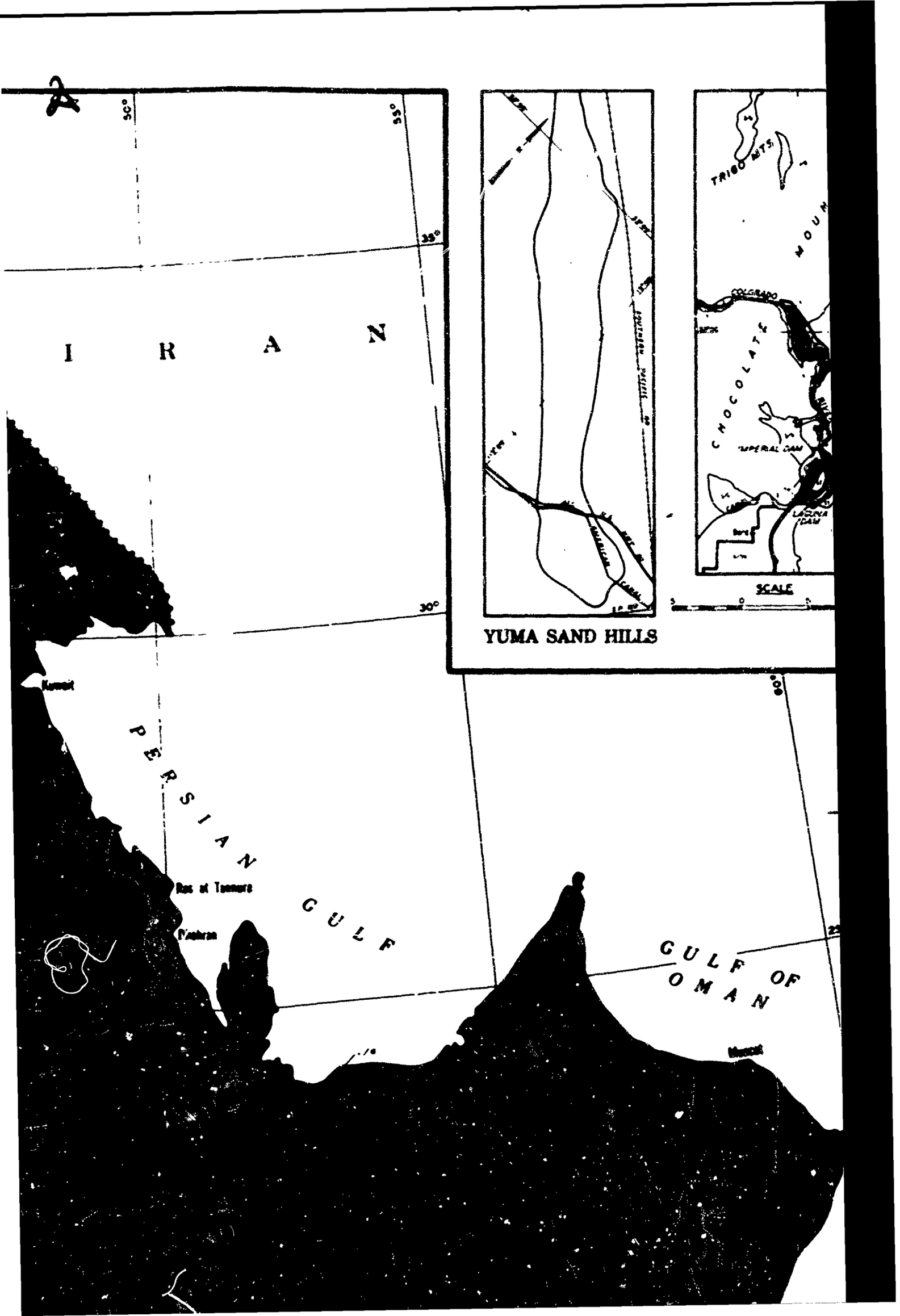
MIDDLE EAST DESERT

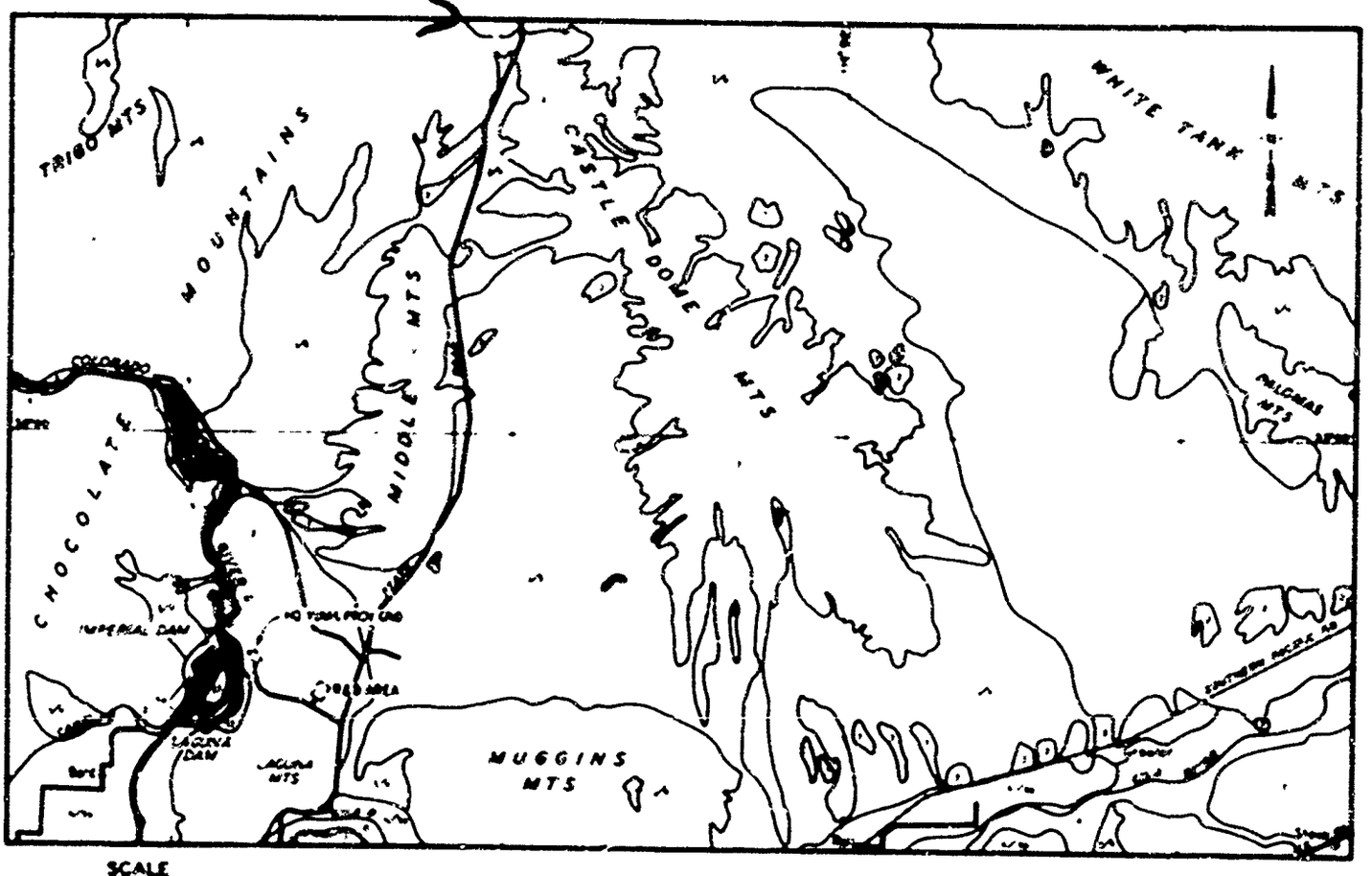
GROUND ANALOGS

8

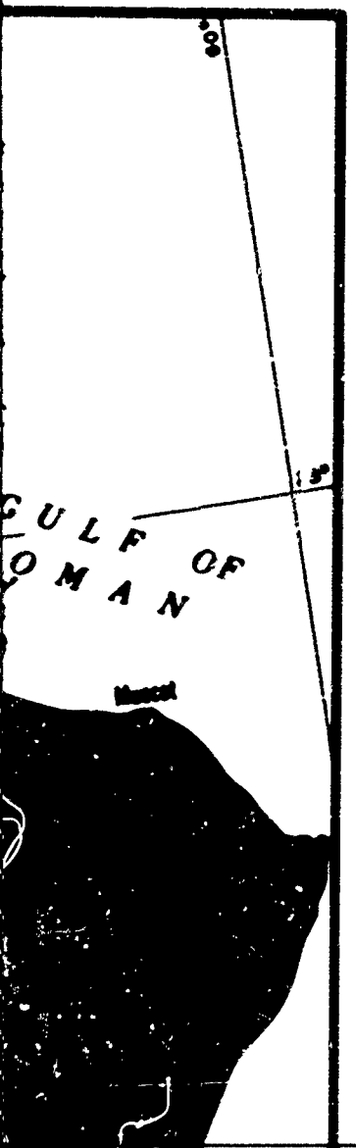
PLATE 11

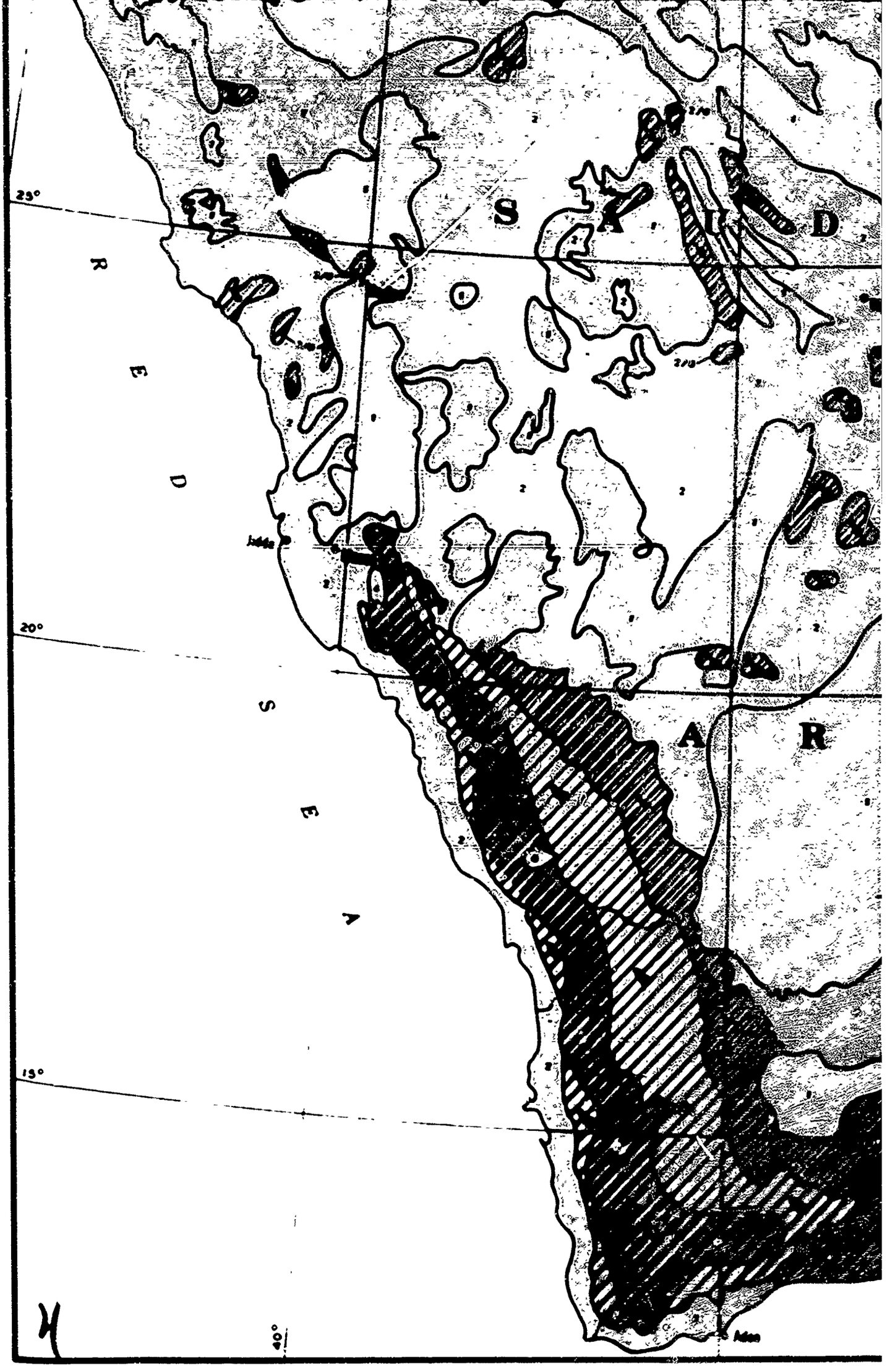
35°
MEDITERRANEAN SEA
35°
BEIRUT
LEBANON
Tel Aviv
EL
30°
Aqaba
25°
R
D
I R A

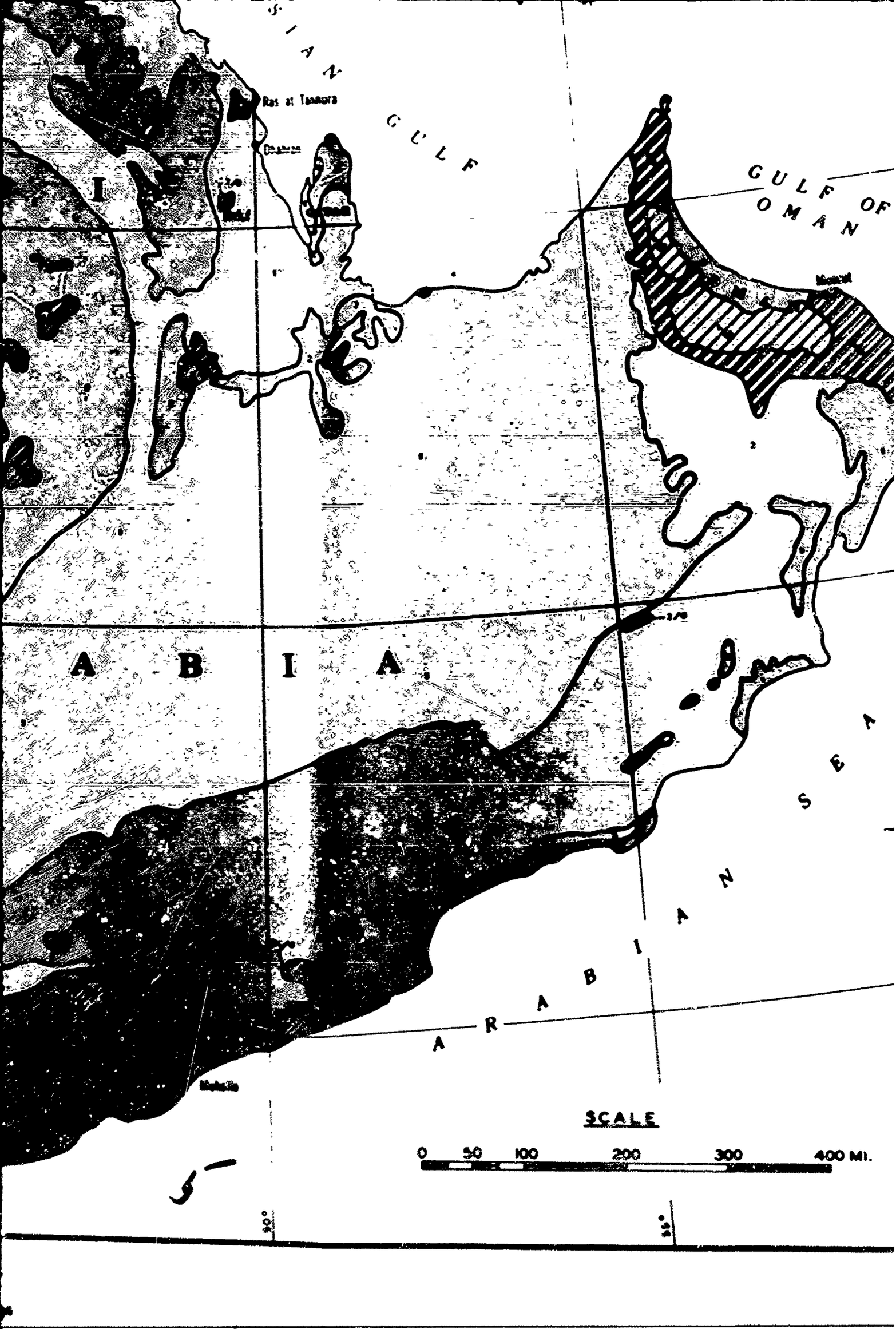

50°
55°
30°
I R A N
PERSIAN GULF
GULF OF OMAN
Kuwait
Ras al Tannura
Bahrain
Muscat
TRIGO MTS.
COLORADO
CHOCOLATE
IMPERIAL DAM
LAGUNA DAM
SCALE
YUMA SAND HILLS

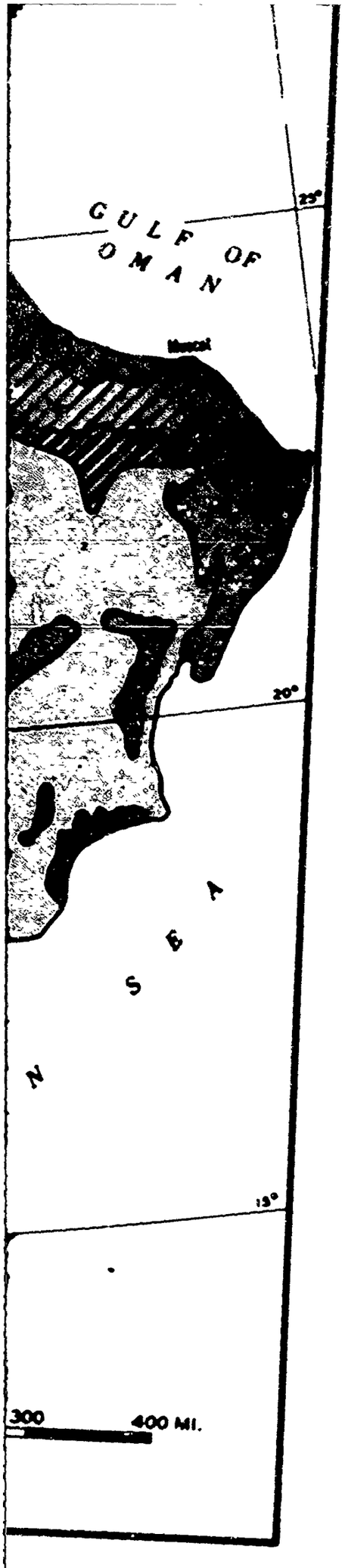


YUMA PROVING GROUND




29°
20°
15°
S
A
D
R
E
D
S
E
A
A
R
Aden


GULF
Ras al Tannura
Dhahran
GULF OF OMAN
Muscat
A B I A
SEA
A R A B I A N
SCALE
0 50 100 200 300 400 MI.



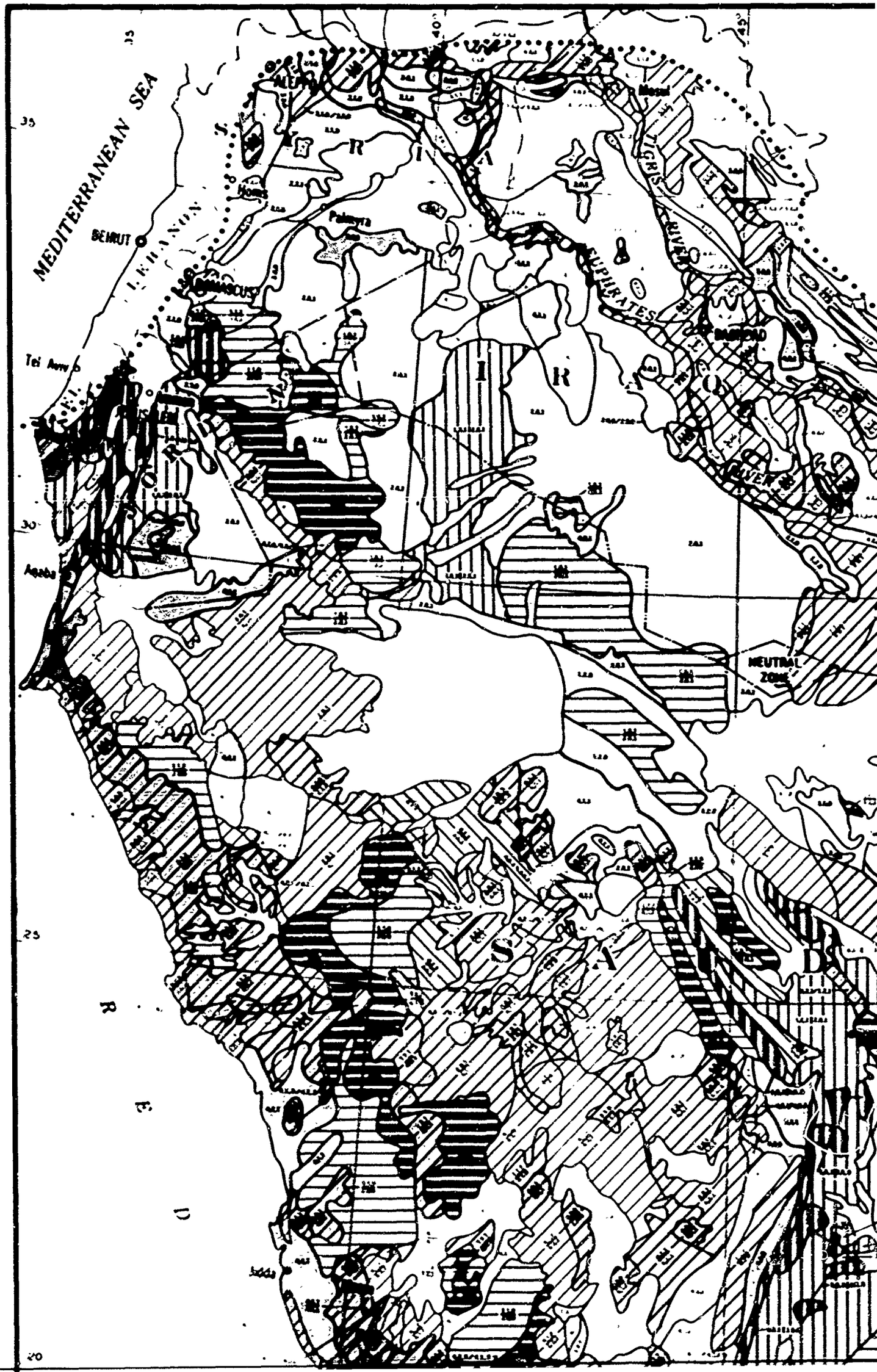
ANALOGS OF YUMA TERRAIN

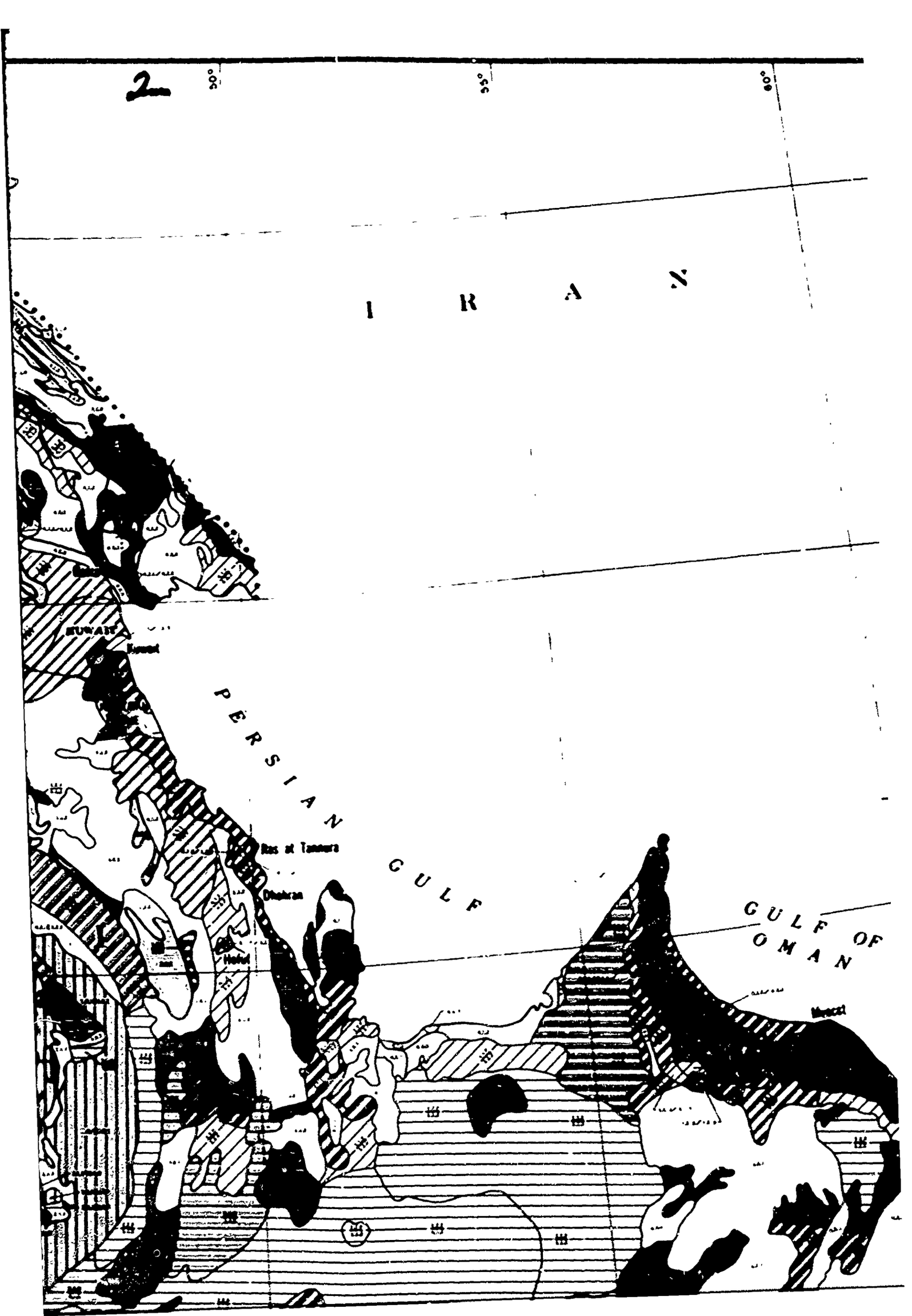
IN THE

MIDDLE EAST DESERT

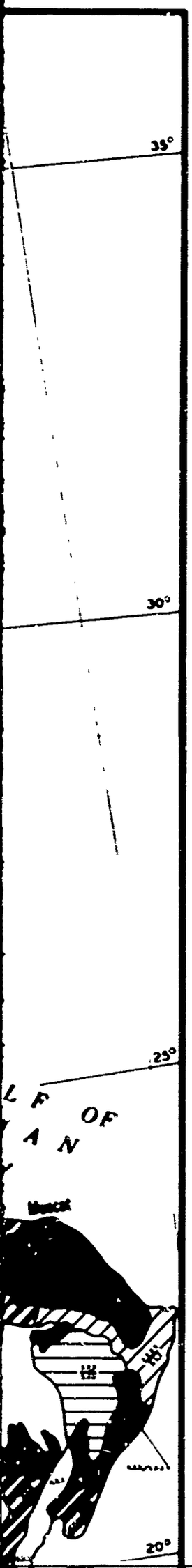
6 VEGETATION ANALOGS

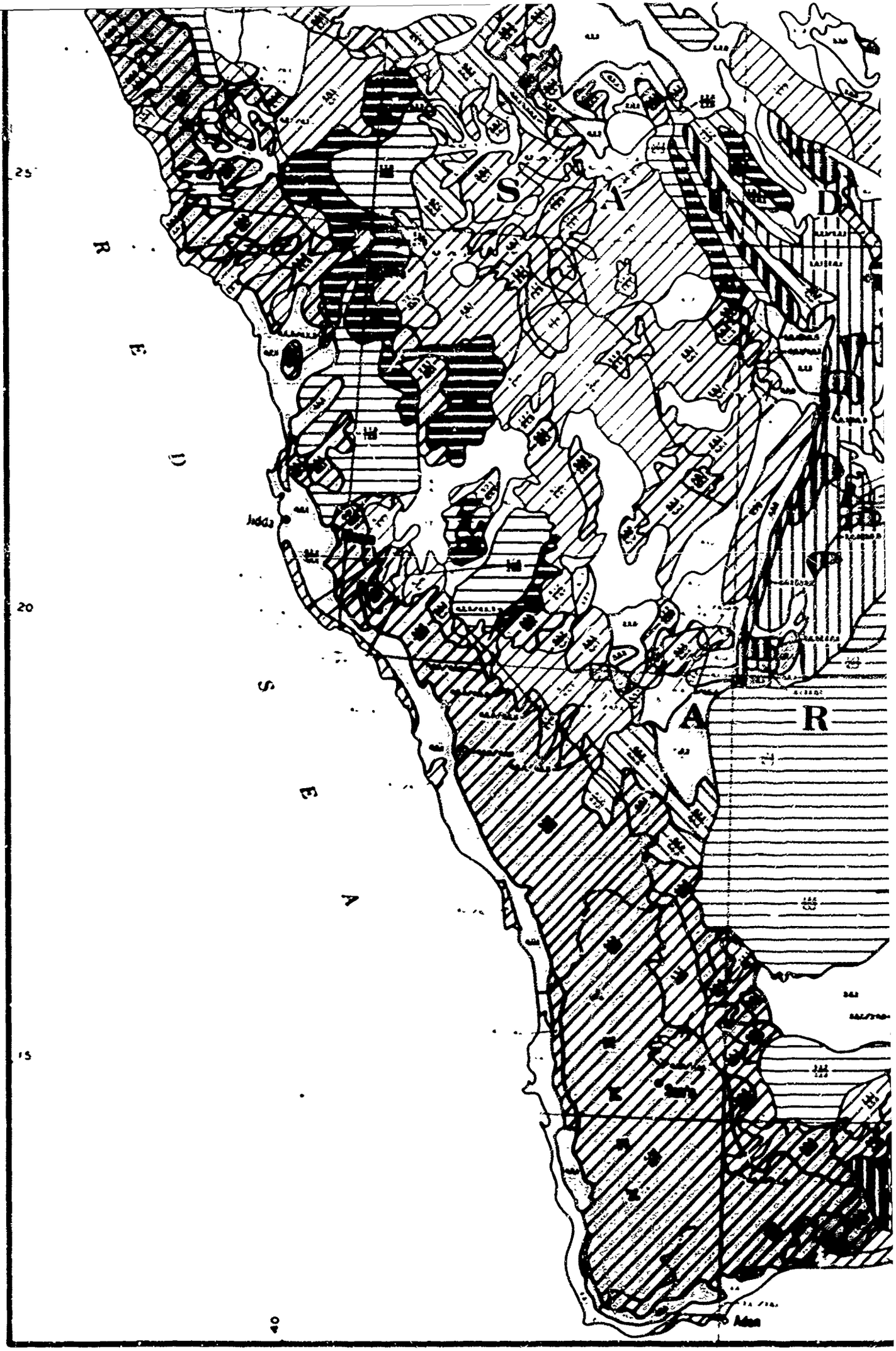
PLATE 12

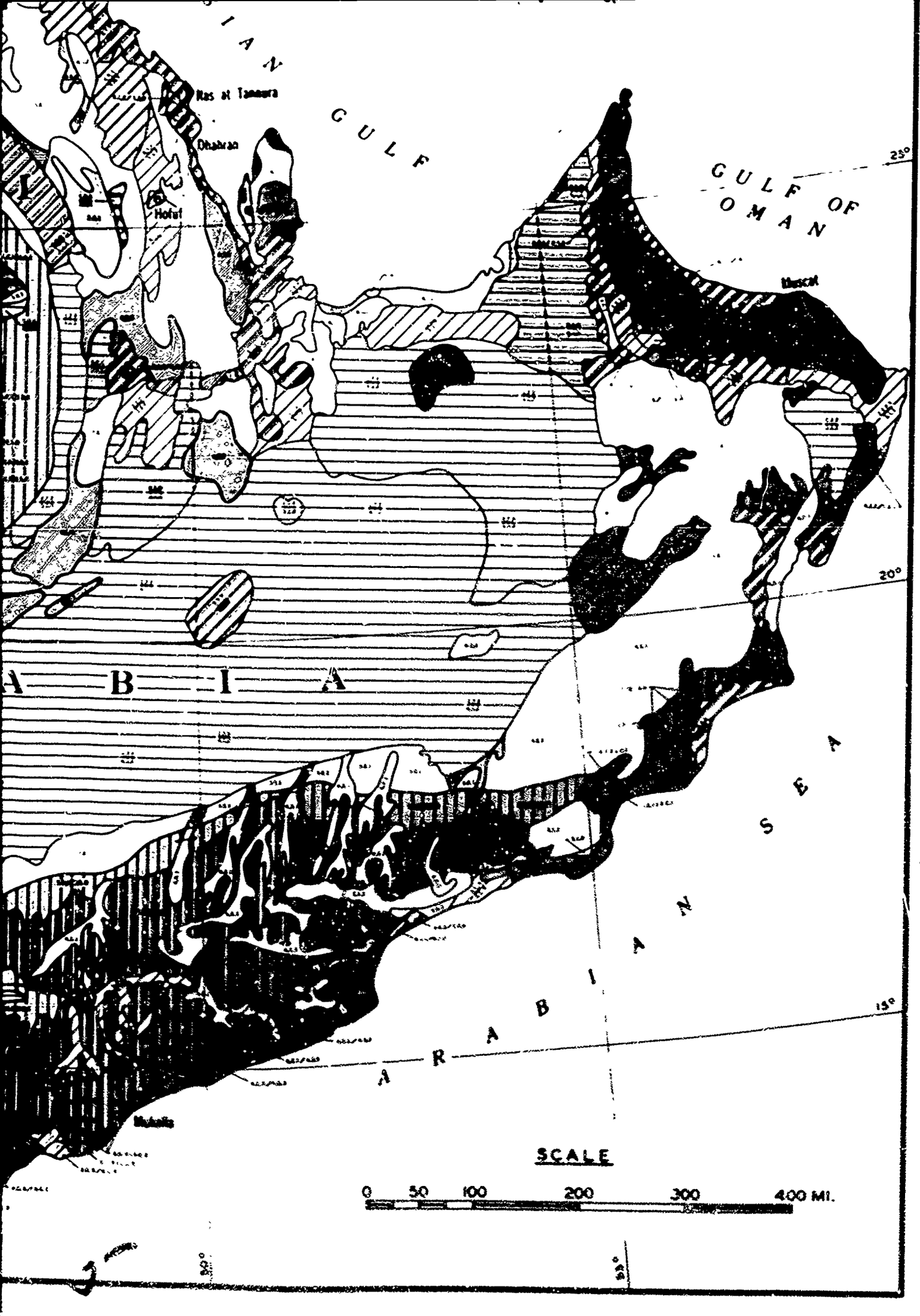

MEDITERRANEAN SEA
BEIRUT
LEBANON
DAMASCUS
Tel Aviv
Amman
Aqaba
Homs
Palmyra
TIGRIS RIVER
EUPHRATES RIVER
BAGHDAD
NEUTRAL ZONE
35
30
25
20

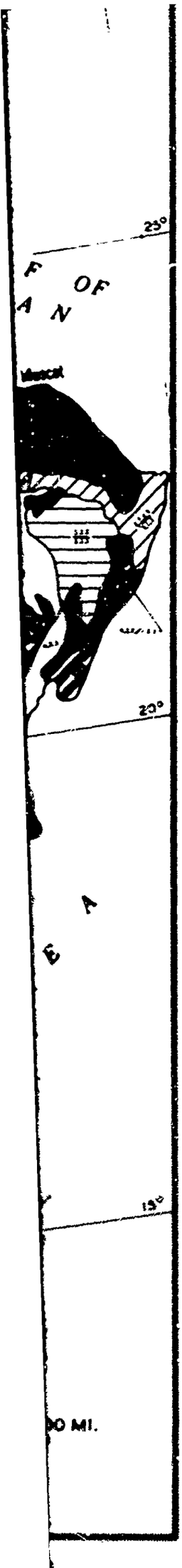

2
IRAN
KUWAIT
Kuwait
PERSIAN GULF
Ras al Tannura
Dhahran
Hofuf
GULF OF OMAN
Muscat

3




S
A
D
R
E
D
S
E
A
A
R
25
20
15
Jidda
Aden


I A N
GULF
Ras al Tannura
Dhahran
Hofuf
GULF OF
O M A N
25°
Muscat
20°
A B I A
S E A
A R A B I A N
15°
SCALE
0 50 100 200 300 400 MI.



ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

6

TERRAIN-TYPE ANALOGS

PLATE 12

ANALOGS OF YUMA TERRAIN IN

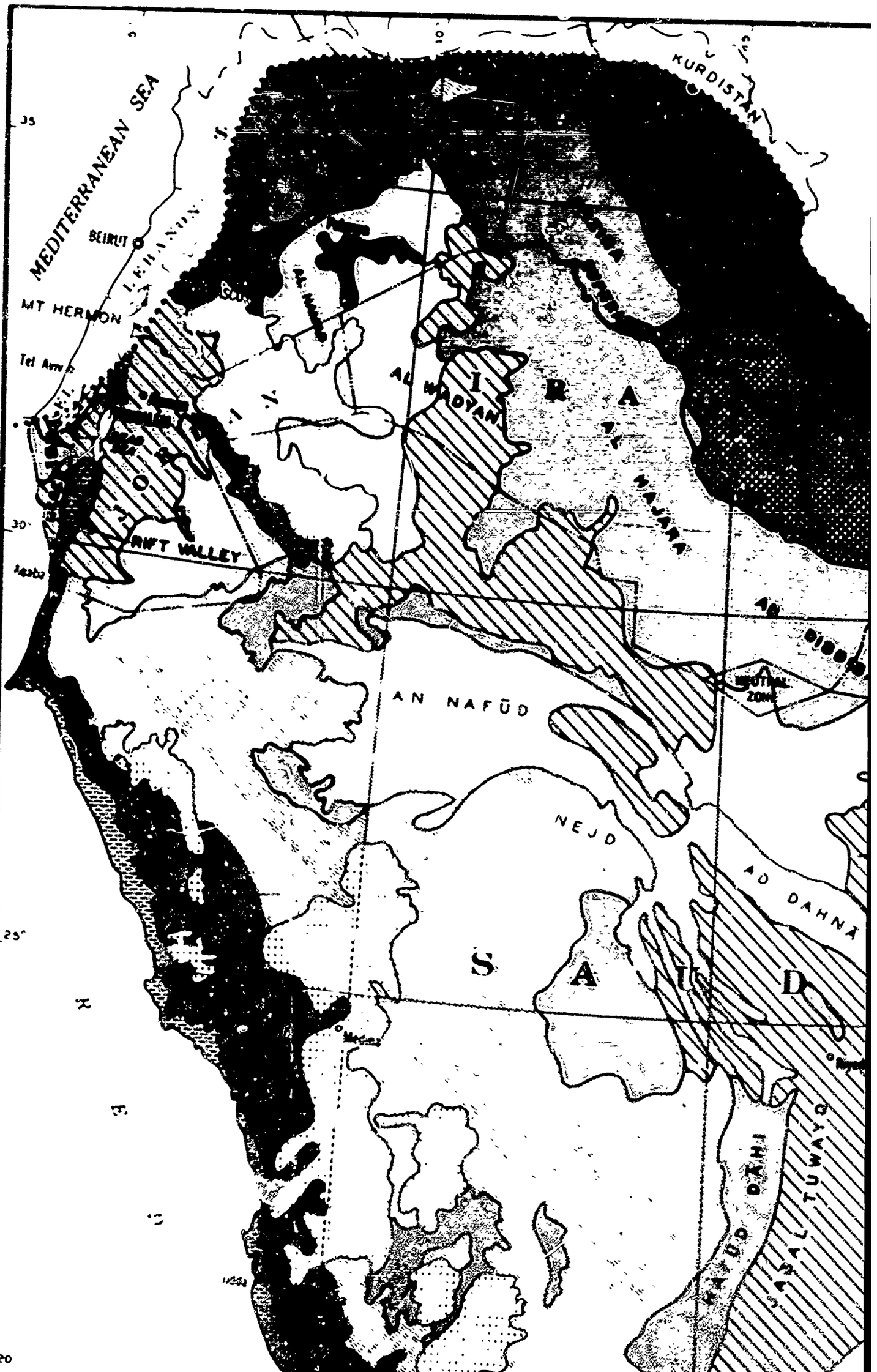
SECTION II: SUPPLEMENTAL M

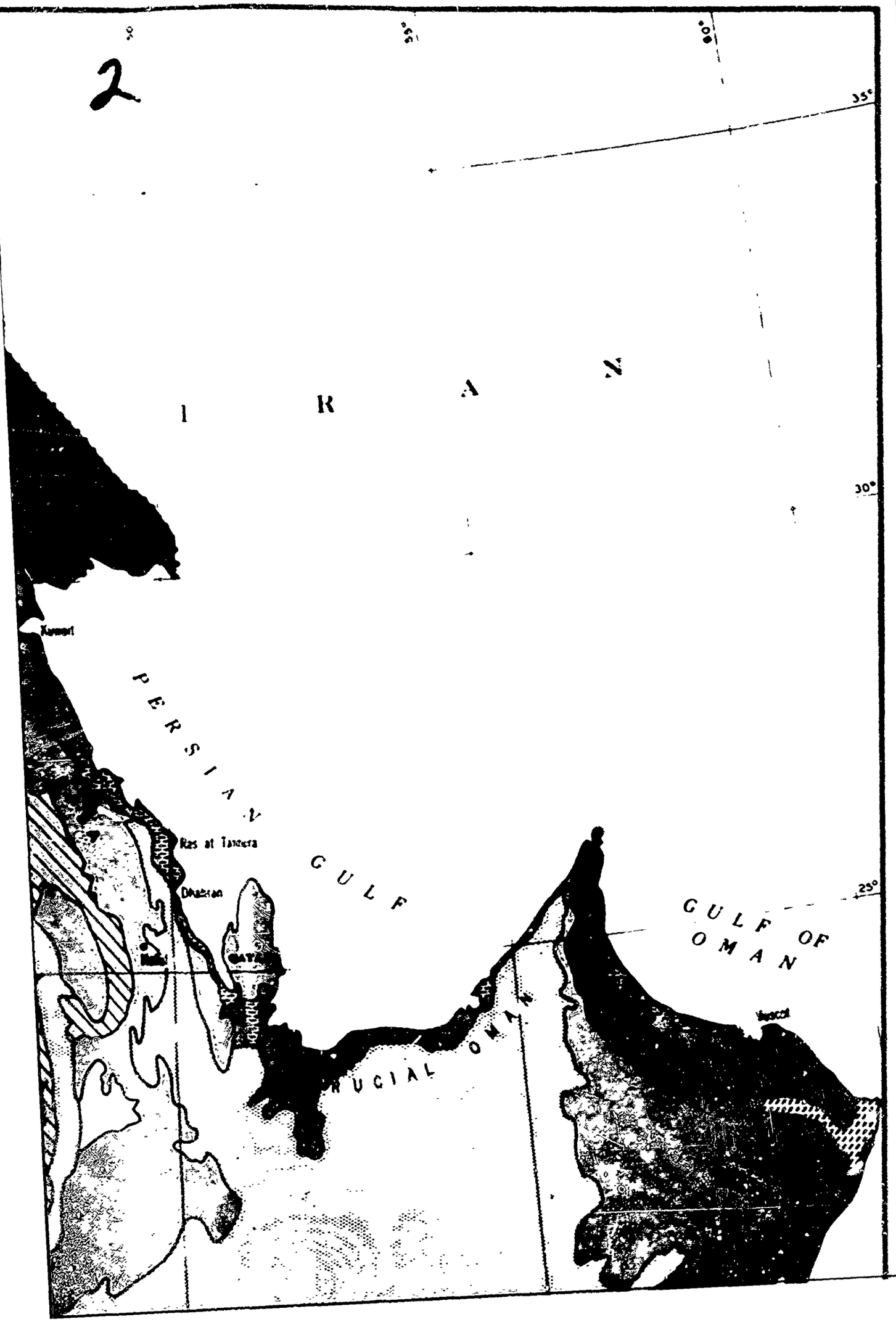
1

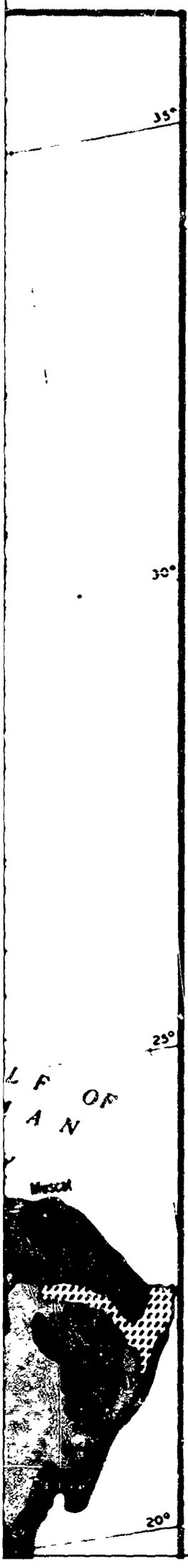
AIN IN THE MIDDLE EAST DESERT

AL MAPS AND TABULATIONS

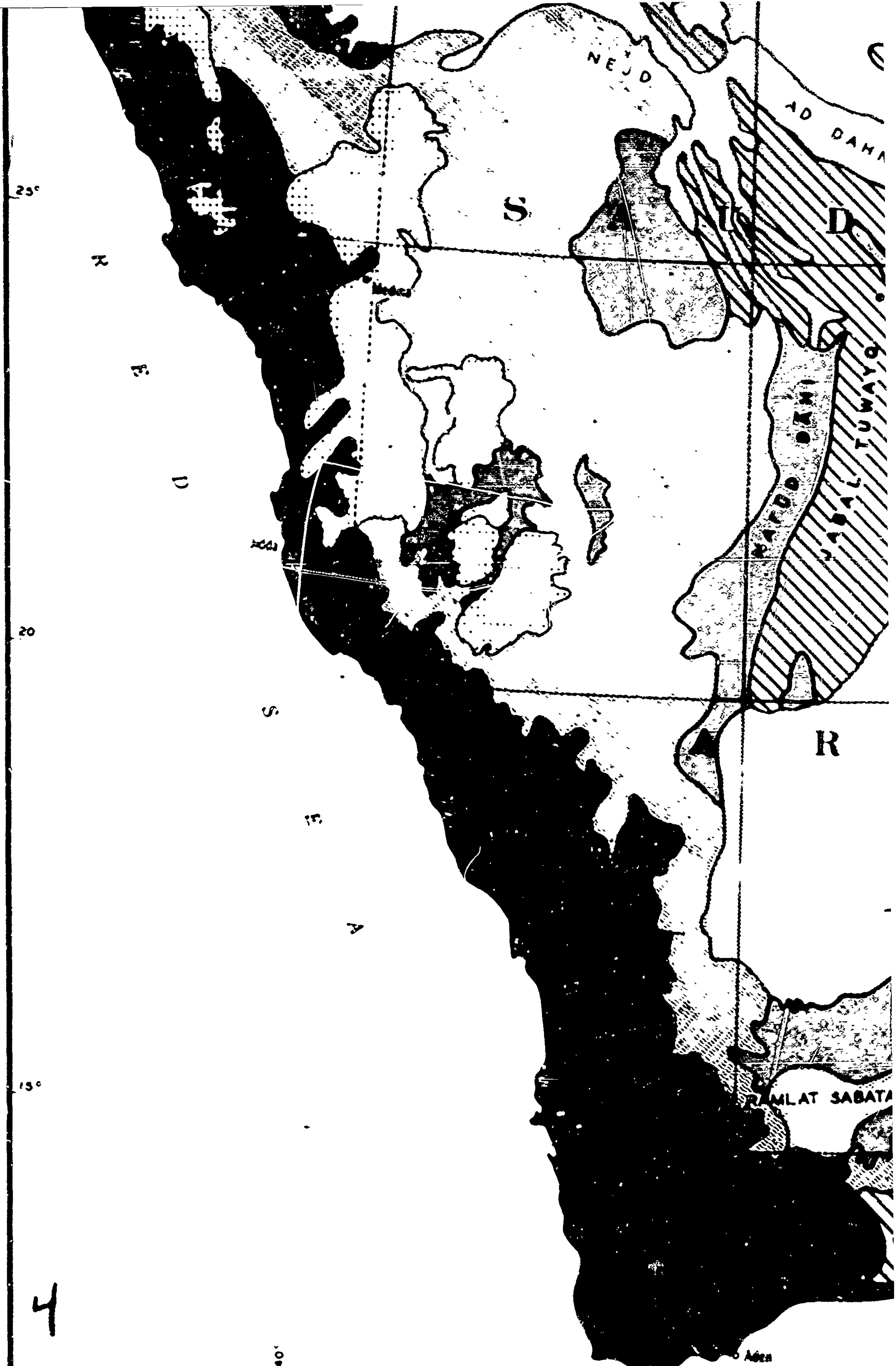
2

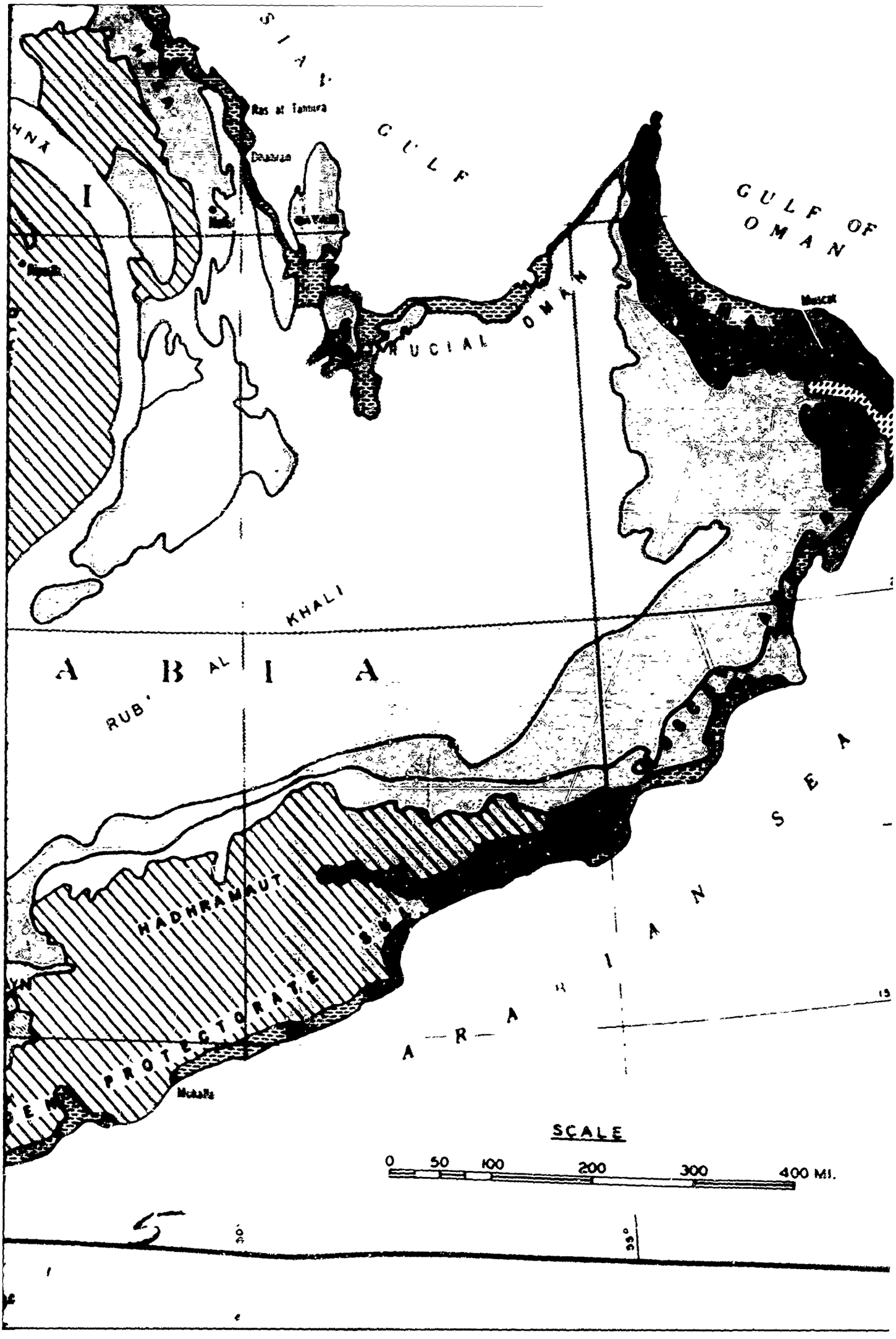

MEDITERRANEAN SEA
KURDISTAN
BEIRUT
LEBANON
MT HERMON
Tel Aviv
AL WADYAN
IRAQ
RIFT VALLEY
Aqaba
AN NAFŪD
NEUTRAL ZONE
NEJD
AD DAHNA
SAUDI
ARABIA
Medina
35
30
25
20

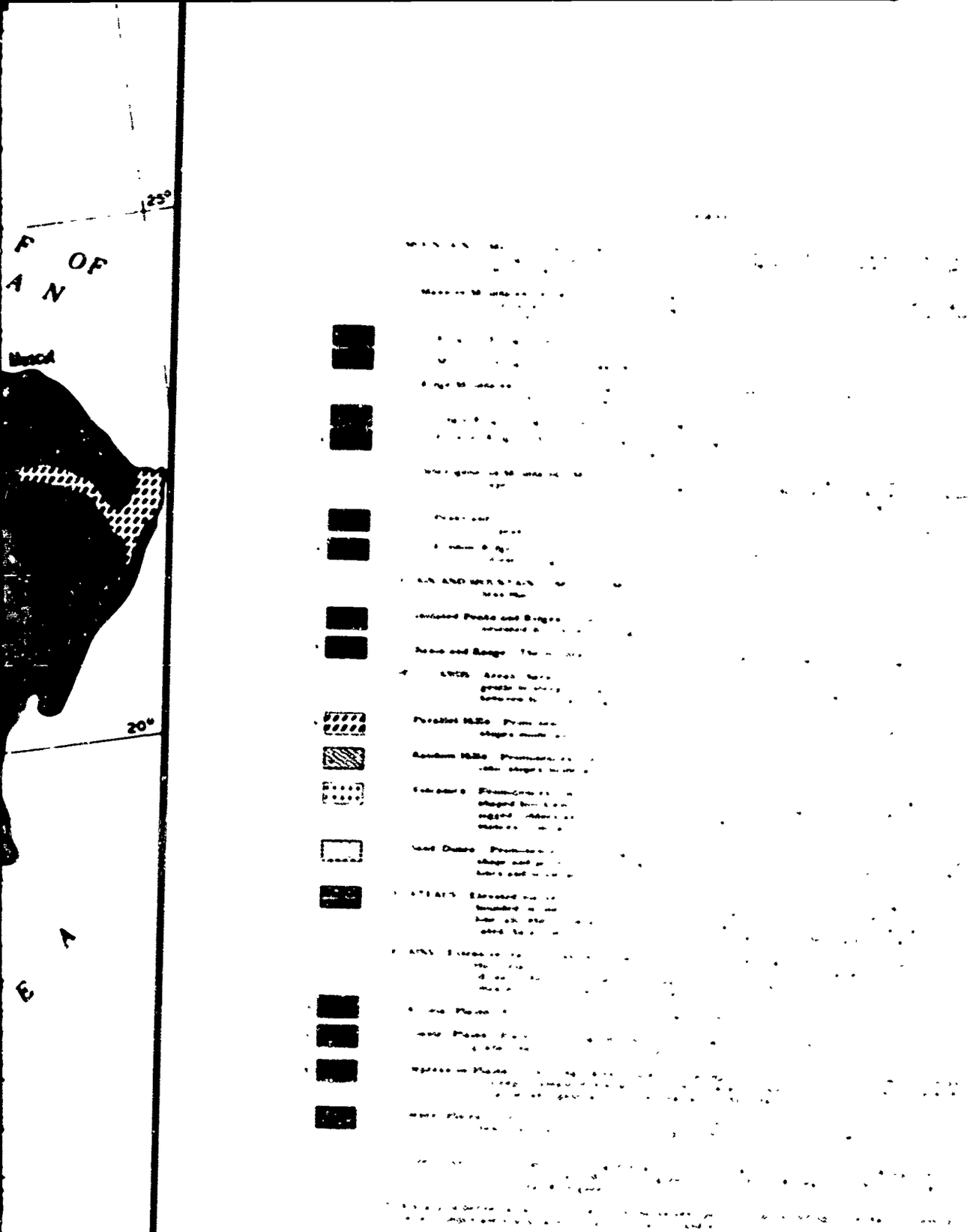

2
35°
I R A N
30°
Kuwait
PERSIAN GULF
Ras al Tannura
Dhahran
25°
GULF OF OMAN
TRUCIAL OMAN



SOUTHWESTERN UNITED STATES


NEJD
AD DAHN
S
U
D
R
RED SEA
NAFUD DAHI
JABAL TUWAYQ
RAMLAT SABATA
Aden
25°
20
15°
40°
4


Ras al Fahtara
GULF
GULF OF OMAN
TRUCIAL OMAN
Muscat
KHALI
A B AL I A
RUB'
HADHRAMAUT
PROTECTORATE
Mukalla
A R A B I A N S E A
SCALE
0 50 100 200 300 400 MI.



ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

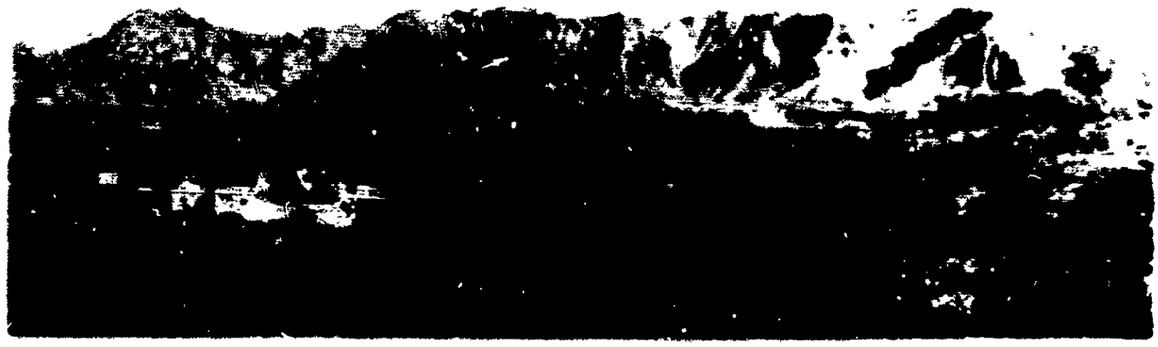
PHYSIOGRAPHY

PLATE 14

PHY

MOUNTAINS:

Mountains are masses of land sha
pared to the basal dimensions and which r
the surrounding terrain. Areas so mapp
massive, ridge, and heterogeneous mounta
places in which the plains occupy more tha
tains of the Middle East are extremely ru
to steep and relief ranging from 50 to
vegetative types has been mapped within t
areas spotted with scattered woodlands a
comprise approximately 13 percent of the
mountains form the entire western rim
Aden in the south to the port of Aqaba in t
tains generally have crest elevations ran
crous peaks in the southern portion of th
western Syria the Qalamoun Mountains ext



M-1. Northwest face of Jabal Jihaf from Al Muriah in the Wadi Tiban in the mountains of western Aden. At 13°45' N, 44°41' E.

M-4. Wadi Baish where it enters the coastal plain from the Hejaz Mountains in western Arabia. At

M-5. Jabel Sannin rising to 8622 ft in the Leba
western Syria. Note terraced lower slopes. A
mately 34°00'N, 35°45'E.

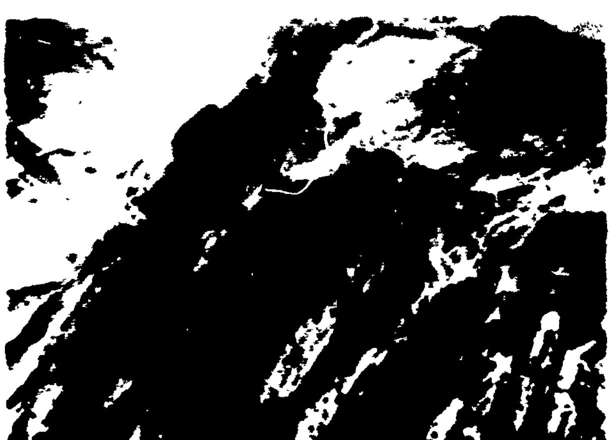
OGRAPHY: 2 DESCRIPTIONS AND PHOTOGRAPHS

re summit areas that are small com-
heights of more than 10,000 ft above
y be entirely mountainous, such as
or they may be plain-mountain com-
percent of the total area. The moun-
, with slopes ranging from moderate
al thousand feet. A wide variety of
mountainous areas. Sparse, scrubby
ltivated zones are typical. Mountains
dle East desert. Ranges of massive
e Arabian Peninsula extending from
rth. These rugged crystalline moun-
from 6000 to 9000 ft; however, num-
ge are known to exceed 11,000 ft. In
ortheast from Mount Hermon, on the

eastern side of the Rift Valley, as three roughly parallel ridges of folde
mentary rock. In northeast Iraq roughly parallel, discontinuous ridges
mentary rock separated by extensive intermontane plains form a basin an
region which marks the transition from the western steppes to the high,
mountains of Kurdistan. In eastern Iraq the Zagros Mountains extend into
as a series of parallel ridge mountains. Genetically the Zagros are par
same mountain mass as the Kurdish ranges to the north. In the extreme
eastern portion of the Arabian Peninsula lies a crescentic band of massive
tains flanked by the great steppes and deserts to the south and west. These
mountains of Oman, an extremely rugged range of igneous and sedimentar
tains trending some 400 miles to the northwest, paralleling the coast o
Along the southern shore of Arabia lies a thin strip of parallel ridge mo
These are structurally part of the Hadhramaut Plateaus, but the processes
sion have created a series of sharp-crested, roughly parallel, sedimentar
several thousand feet in elevation.

Britannica '50

M-2. View southward toward Ma'bar from the Naqil isla pass, elevation 9600 ft. in the mountains of southern Yemen. At 14°46' N, 44°20' E.



By James L. Oakeson

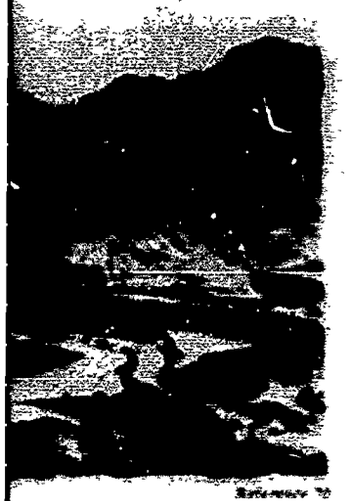
M-6. Upper fold and steppe zone in the Basin and Range region of northeastern Iraq. At ap-

By James

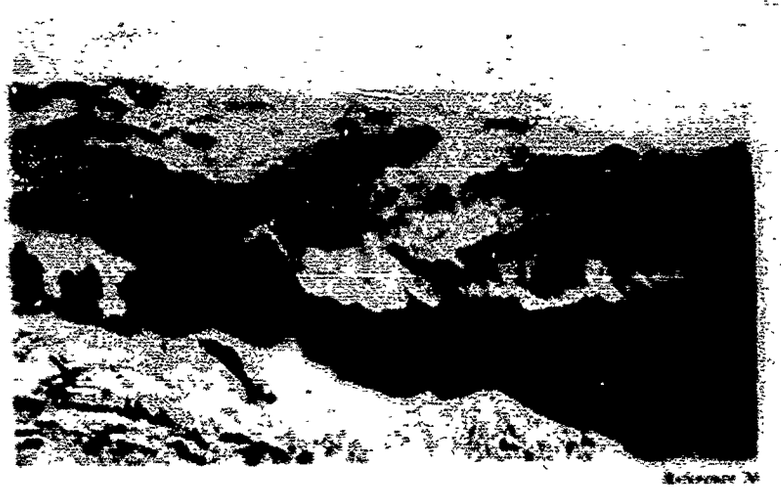
M-7. Mountains along the Iranian bor looking southwest from Kalah-I-Basr

RAPHS

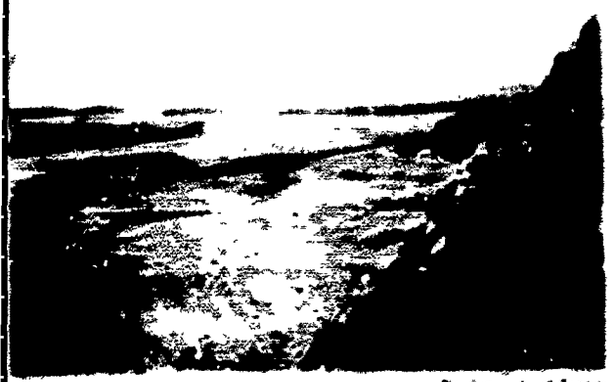
three roughly parallel ridges of folded sedi- roughly parallel, Mesozoic ridges of sedi- intermontane plains form a basin and range from the western steppes to the high, rugged Iraq the Zagros Mountains extend into the area mains. Genetically the Zagros are part of the ish ranges to the north. In the extreme south- sands lie a crescentic band of massive moun- and deserts to the south and west. These are the rugged range of igneous and sedimentary moun- the northeast, paralleling the coast of Oman. a like this strip of parallel ridge mountains. mountains, but the processes of ero- -created, roughly parallel, sedimentary ridges



, elevation 9600 ft.



M-3. View from eastern edge of the top of Jabel Harir, elevation 7700 ft, in the southwestern mountains of Arabia. At 13°46' N, 46°52' E.



M-7. Mountains along the Iranian border.

M-8. Oman Mountains north of Buraimi, at approximately 22°30' N.

M-1. Northwest face of Jabal Jihaf from Al Murich in the Wadi Tibaa in the mountains of western Aden. At 13°45' N, 44°41' E.

M-4. Wadi Baish where it enters the coastal plain from the Hejaz Mountains in western Arabia. At approximately 17°23' N, 42°30' E.

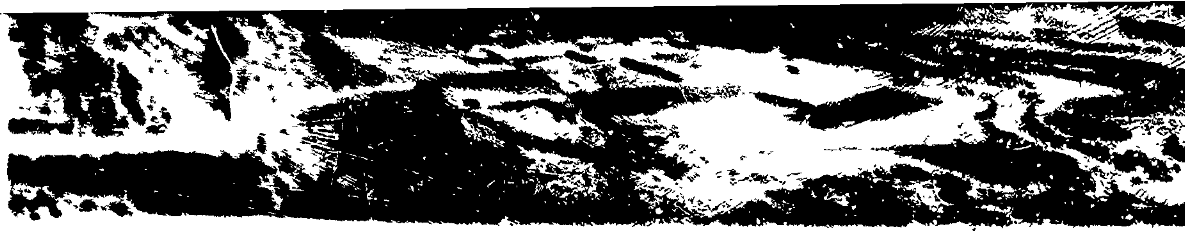
M-5. Jabal Sanain rising to 8622 ft in the Lebanon western Syria. Note terraced lower slopes. At mately 34°00'N, 35°15'E.

M-9. Jabal Kaur in mountainous Oman as seen from the west. At approximately 22°57' N, 56°53' E.

M-10. Drowned valley near Ras the northern tip of Oman. At app 26°20' N, 56°30' E.

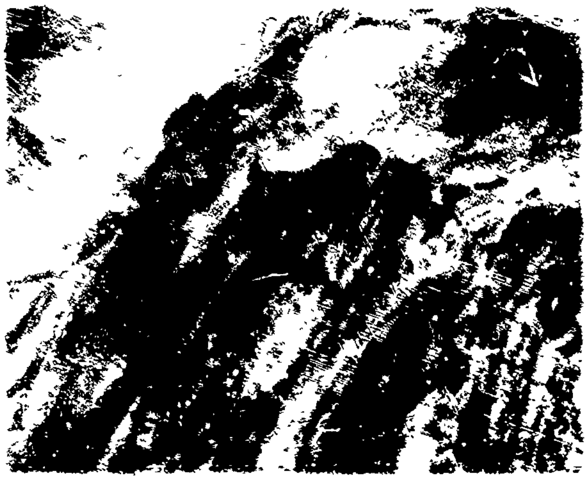
4

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume



M-2. View southward toward Ma'bar from the Naqil Isla pass, elevation 5600 ft, in the mountains of southern Yemen. At 14°46' N, 44°20' E.

...ebanon range, ... At approxi-



M-6. Upper fold and nappe zone in the Basin and Range region of northeastern Iraq. At approximately 35°30' N, 45°20' E.

M-7. Mountains along the Iran... looking southwest from Kalak... At 33°20' N, 46°20' E.

... Ras Masandam on ... approximately

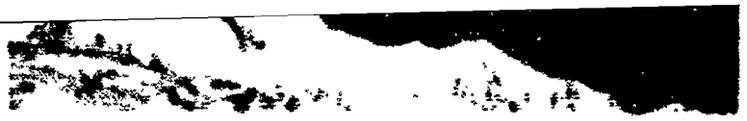
M-11. Dissected limestone country of Ruus al Jibal looking southwest from Khasab on the Masandam Peninsula. At 26°11' N, 56°15' E.

M-12. Foothills of the O... from the Wadi Jizz in the... At approximately 24°25'...

...lume I of this report

Reference 76

, elevation 9600 ft.



Reference 76

M-3. View from eastern edge of the top of Jabel Harir, elevation 7900 ft, in the southwestern mountains of Arabia. At 15°44' N, 44°32' E.

M-7. Mountains along the Iranian border, looking southwest from Kalak-i-Bustarg. At 33°30' N, 46°20' E.

Reference 72

M-8. Oman Mountains north of Buraimi. At approximately 22°30' N, 56°00' E.

Reference 45

M-12. Foothills of the Oman Mountains as seen from the Wadi Jizu in the Batina coastal plain. At approximately 24°25' N, 56°39' E.

Reference 23

M-13. Western end of the Aden peninsula seen eastwards from the air.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

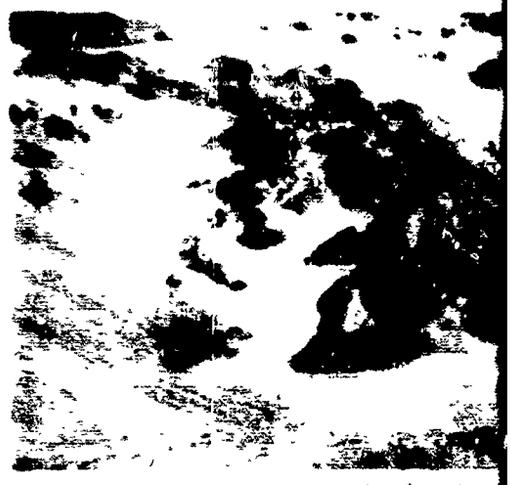
PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

HILL LANDS:

Hill lands are areas characterized by prom
that rise to heights of less than 1000 ft above the
mapped may consist of hill masses or of hills s
occupy as much as 75 percent of the total area.
position of hill lands vary widely. They may co
composed of igneous, metamorphic, and sediment
materials; volcanic hills, composed of lava or
into a wide variety of types by the wind. Slopes v
to steep, and relief ranges from 10 to 700 ft. The
characteristically barren of vegetation, whereas
support a sparse vegetative cover. Hill lands com
the Middle East desert. Random hills of crystalli
the great central tableland of Arabia which flanks
and slopes gently toward the Persian Gulf to the e
these hill lands are composed predominantly of

H-1. Crateve and lava-flows north of Jabal Hakl in western Arabia. At 19°17' N, 44°04' E.



H-2. Maturely dissected hill lands in western Transjordan near Aqaba. Ga masses projecting from vast areas of and sand. At 29°33' N, 35°25' E.

H-6. Crystalline hill in the Jabal Aja Range near Tawaiye in central Arabia. At 27°44' N, 41°36' E.

H-7 Weathered crystalline hill in south central Arabia. At 29°44' N, 37°36' E.

H-8. A typ approximate

2

RAPHY: DESCRIPTIONS AND PHOTOGRAPHS

...ocene, of small ... ul area, ...rrounding terrain. Areas so ...arated by plains ... such may ... The characteristic ... of some ...et of parallel or ... hills ...y rock or ... consolidated ...ers; or ... areas, ...sculptured ...in hill lands ... gentle ...unes and the ... hills are ... parallel and ... hills may ...se approximately ... percent of ... rock form the ... part of ... great western ... main range ... In their northern extremity, ...sedimentary rocks. However,

immediately adjacent to the western mountains they are interrupted by volcanic harrats, i.e. vast fields of basaltic lava surmounted by groups of cinder cones. The harrats extend in a broken belt from the Aden Peninsula in the south to the Harrat district of southern Syria. Sand dunes occupy much of southern Arabia with the greatest concentration being in the Rub' al Khali, a sand dune area of 350,000 square miles and second only to the Sahara in size. From the northern part of this vast sea of longitudinal dunes, thin strips of sand desert, composed of low dunes, project in a northwesterly direction and terminate in the An Nafud -- the northern desert of Arabia. Smaller dune areas are found scattered throughout the peninsula, the most notable of which are the Nafud Dahi in central Arabia, the Ramlat Sabatayn in southern Arabia, and the Hasa plain in eastern Arabia. Parallel hills have been mapped in two small areas, a small zone flanking the southeastern extremity of the Oman Mountains and a hilly area to the west of Jerusalem. The gross topography of both areas is the surface expression of folding in sedimentary rocks.

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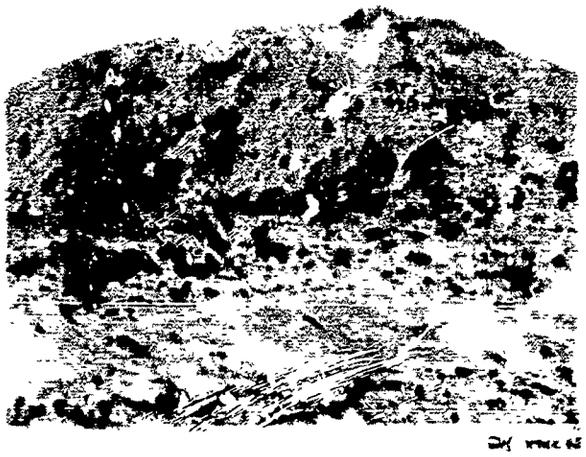

H-1. A granite knob as seen from the Wadi Tayib in the hill lands of southwestern Arabia.

H-4. Interior of Harrah volcanic crater in the hill lands of southwestern Arabia. At 18°25' N, 46°48' E.

...l longitudinal dune in the Rub al Khali. At ... 22°30' N, 52°30' E.

H-9. Dune massifs in southern Liwa in northeastern Rub al Khali. At approximately 23°00' N, 53°10' E.

PHS

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surmounted by groups of cinder cones.
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the Hasa plain in eastern Arabia. Par-
areas, a small zone flanking the south-
nd a hilly area to the west of Jerusalem.
surface expression of folding in sedi-

Reference 61

terior of Karab volcanic crater in the
n of southwestern Arabia. At 14°26' N,
E.

Reference 62

H-9. Badly weathered crystalline hill in the Hima Valley in southwestern Arabia. At 18°15' N, 44°30' E.

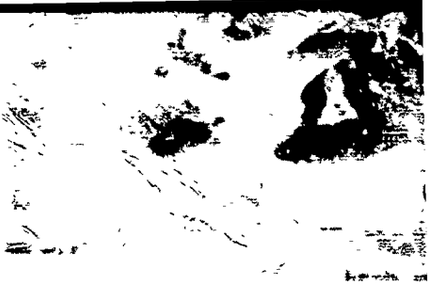
Reference 63

Lava in northeastern Rub al
N, 53°10' E.

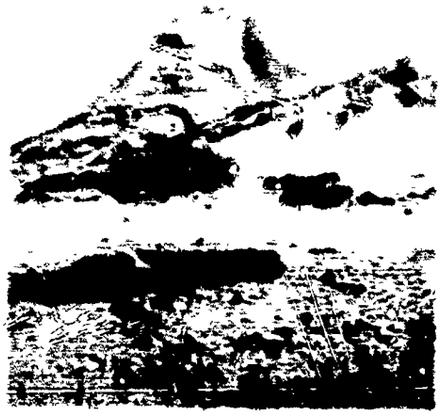
Reference 4

H-10. A deep horseshoe depression in the An Nafud in northern Arabia. At approximately 28°30' N, 41°30' E.

H-1. Craters and lava-flows north of Jabal Kahl in western Arabia. At 19°47' N, 44°04' E.



H-2. Maturely dissected hill land western Transjordan near Aqaba. masses projecting from vast area sand sand. At 29°35' N, 35°25' E.



H-6. Crystalline hill in the Jabal Aja Range near Yuwaiya in central Arabia. At 27°44' N, 41°36' E.

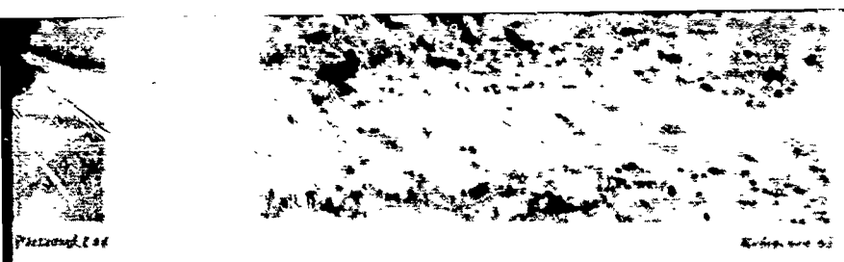
H-7. Weathered crystalline hill in north central Arabia. At 29°44' N, 37°36' E.

H-8. A t approxim

H-11. Isolated barchan dunes between Dammam Dome and the northern Jafura desert in eastern Arabia. At approximately 26°17' N, 50°00' E.

H-12. Gahunim sand dune, typical of the Rub' al Khali. At approximately 19°55' N, 54°30' E.

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this



...south-
...st rock
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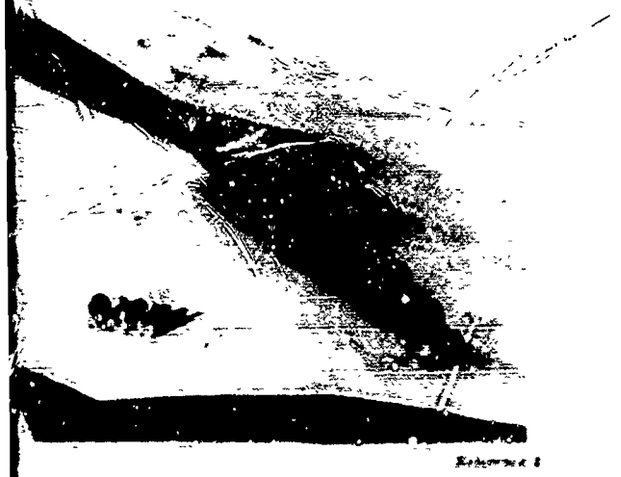
...d-3. A granite boss as seen from the Wadi ...arib in the hill lands of southwestern Arabia.

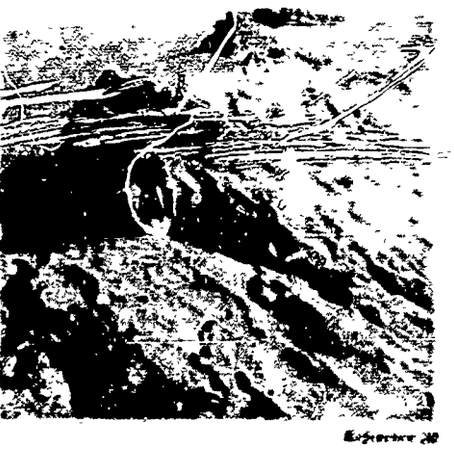
II-4. Interior of Karsh volcanic crater in the hill lands of southwestern Arabia. At 14°35' N, 46°45' E.



...l longitudinal dune in the Rub al Khali. At 22°30' N, 52°30' E.

II-9. Dune massifs in southern Liwa in northeastern Rub al Khali. At approximately 23°00' N, 53°10' E.

II-13. Wind-blown sand encroaching on the date gardens of Qatif in the Hasa. At 26°32' N, 50°00' E.



II-14. Fossil dune at Muraikhat in the Hasa Plain of eastern Arabia. At 26°24' N, 50°07' E.

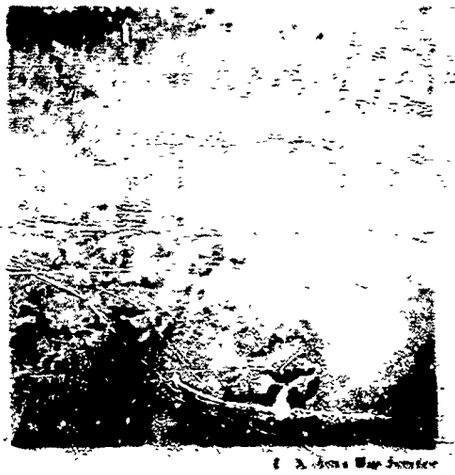
II-15. Active dunes on a ... plain in western Arabia. ...43°05' E.

or of Karah volcanic crater in the
southwestern Arabia. At 14°35' N,

H-5. Badly weathered crystalline hill in the Iiima Valley in southwestern Arabia. At 18°15' N, 44°30' E.

in northeastern Rub al
53°10' E.

H-10. A deep horseshoe depression in the An Nafud in northern Arabia. At approximately 28°30' N, 41°30' E.



H-15. Active dunes on an old peneplain in western Arabia. At 21°00' N, 43°05' E.

H-16. Dune patterns created by a variable wind regime on a peneplain in southern Rub al Khali. At 18°45' N, 52°50' E.

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

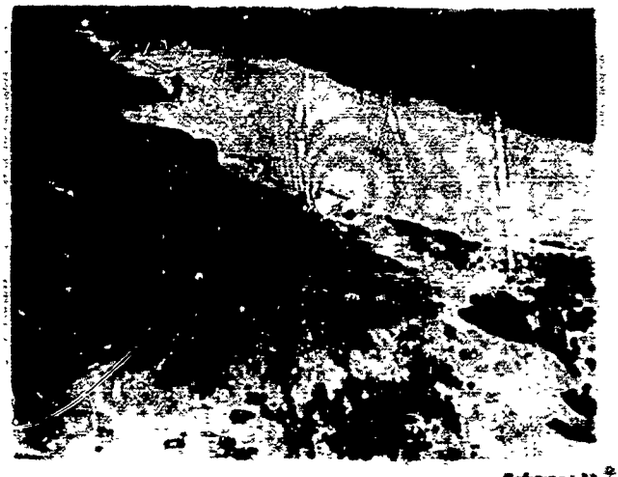
PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

PHYSIO

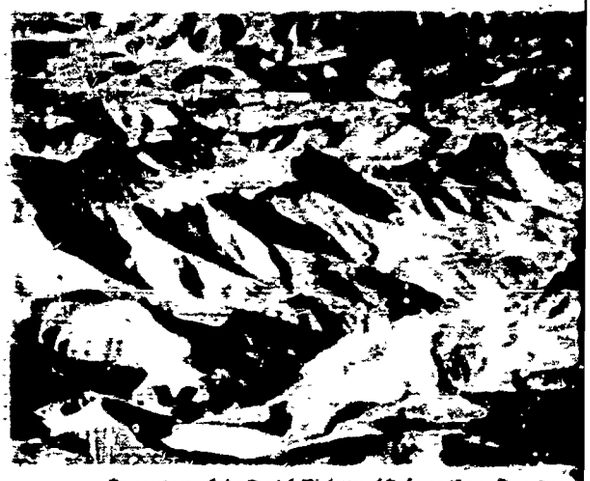
PLATEAUS:

Plateaus are elevated masses of land cha
less flat-lying summit areas bounded on one or
100 ft in height. Dissected plateaus have been
of the original surface remains. Approximate
desert consists of plateaus, some 80 percent of
sected plateaus. The average slope of a plateau
than 1 degree; however, some summits have sur
rolling and exhibit slopes ranging up to 6 degree
may range up to 10 ft, whereas the rolling plate
10 to 50 ft. Depth of dissection along the major d
ceed 1000 ft. The plateaus were formed in area
mentary rock of which sandstone and limestone
types. In general, plateau summits lie between e
plateaus of the Middle East may be conveniently
Southern Plateaus, (2) the Central Plateaus, an
southern section of the Hadhramaut, as it is ca
impressive plateau regions of the world. Deep
1000 ft deep and several miles across, cut the



Reference 22

P-1. Wadi 'Amd at Hureidha in the Hadhramaut, Southern Arabia.



By courtesy of the British Ministry of Defence (Navy Department)

P-2. The Jordan Plateaus between Jerusalem and Jericho as seen from the air. Exact location unknown.

Reference 12

P-6. Plateau surface above Tarim in the Hadhramaut. At approximately 16°05' N, 48°30' E

Reference 17

P-7. Typical plateau surface south of the Wadi Hadhramaut. At approximately 15°45' N, 48°30' E

GRAPHY: DESCRIPTIONS AND PHOTOGRAPHS

cterized by extensive, more or
ry sides by scarp greater than
pped where less than 5 percent
21 percent of the Middle East
hich have been mapped as dis-
mmit is characteristically less
es which are more undulating or
Relief on the flat-lying summits
scarps have relief ranging from
inageways may occasionally ex-
f bedded horizontal-lying sedi-
the most commonly occurring
vations of 1000 and 2000 ft. The
vided into three sections: (1) the
(3) the Northern Plateaus. The
ed, is certainly one of the most
inding wadis, often as much as
untry into great isolated blocks
of tableland. The Hadhramaut has a steep seaward-facing scarp and slopes gently to the north where it grades without a distinct break into the Rub' al Khali Desert. The central section consists of a series of roughly concentric basins of plateau separated by thin strips of sand desert. They reach their greatest elevations in the west and grade gently eastward until they dip beneath the plain bordering the Persian Gulf. The westernmost of these plateaus, Jabal Tuwayq, is intensely dissected, and travel through this area is restricted to the beds of a few deep wadis. To the east the plateaus occur as relatively undissected flat-lying areas of bedrock often covered with a thin veneer of wind-polished gravel. The northern plateaus occupy much of the northwest portion of the study area. They are bounded on the north by the Qalamun Ranges and the Euphrates River and extend in a southeast direction until they merge with the central plateaus to the south. To the east the plateaus gradually grade into desert plains. In general, they have their greatest dissection in the west. The western component of this area is separated from the eastern by the large volcanic area that extends from Damascus to the southeast through Syria, Transjordan, and into northern Saudi Arabia. The Al Wadyan Plateau, immediately to the east of these lava fields, is dissected by innumerable shallow wadis.

By courtesy of the British Ministry of Defence (Navy Department)

P-3. View eastward from the Deir Plateau region in Jordan, near Petra. Exact location unknown.

By courtesy of the British Ministry of Defence (Navy Department)

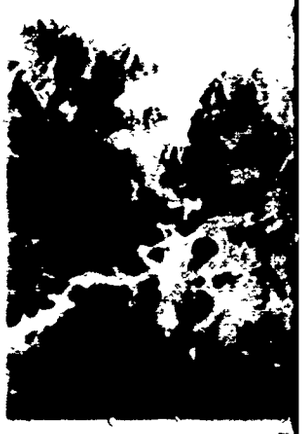
P-4. Crater of Jebel Seys, Jebel Druse volcanic plateau region, Syria. At 33°25'N, 36°50'E.

Reference 12

P-8. Aerial view of the dissected Hadhramaut plateaus showing the

By courtesy of the British Ministry of Defence

P-9. The Sagta Pass in Jabal Tuwaiq in central Arabia. At



P-10. Intensely dissected the plateau bordering the

APHS

ep seaward-facing scarp and slopes gently
stinct break into the Rub' al Khali Desert.
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They reach their greatest elevations in
they dip beneath the plain bordering th
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wind-polished gravel. The northern pla-
gn of the study area. They are bounded on
e Euphrates River and extend in a south-
central plateaus to the south. To the east
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By courtesy of the British Ministry of Defence (Navy Department)

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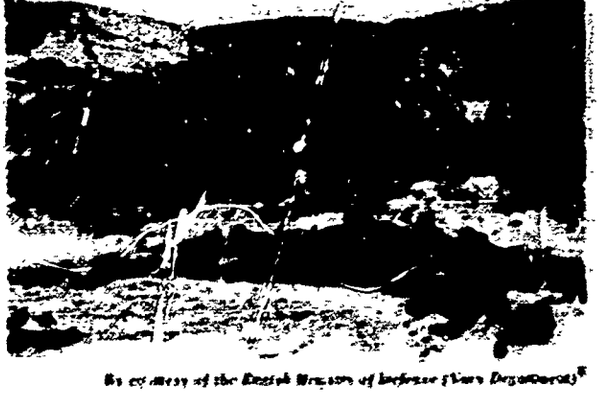
gion, Syria. At 33°25'N, 36°50'E.



By courtesy of the British Ministry of Defence (Navy Department)

P-5. Safa lava flood, Jebel Druse, Syria. At 33°25'N, 36°40'E.

U. S. Army Map Service

P-10. Intensely dissected edge of the plateau bordering the Wadi Araba in southern Palestine. At 30°09' N,

Bulletin of the Amer. Assoc. of Petroleum Geologists

P-11. Looking up the Wadi Zerqa in the Jordan Plateaus north of the Dead Sea. At approximately

P-1. Wadi 'Amd at Hureidha in the Hadhramaut, Southern Arabia.

P-2. The Jordan Plateaus between Jerusalem and Jericho as seen from the air. Exact location unknown.

P-6. Plateau surface above Tarim in the Hadhramaut. At approximately 16°05' N, 48°58' E.

P-7. Typical plateau surface south of the Wadi Hadhramaut. At approximately 15°45' N, 49°00' E.

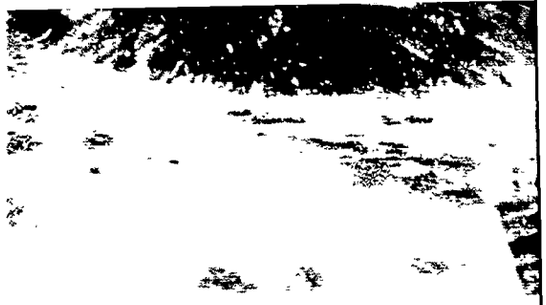
P-12. Intensely dissected plateau region near Jabel Ram in southwestern Transjordan. At 29°35' N, 35°25' E.

P-13. A line of rugged peaks rising sharply from the margins of the Wadi Arabu south of the Dead Sea. At 29°55' N, 35°05' E.

4

• Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I of this rep

P-3. View eastward from the Deir Plateau region in Jordan, near Petra. Exact location unknown.



P-4. Crater of Jebel Seyo, Jebel Druse volc plateau region, Syria. At 33°25'N, 36°50'E.

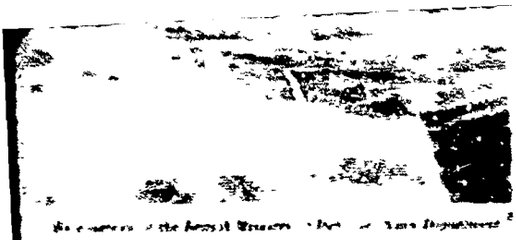
P-8. Aerial view of the dissected Hadhramaut plateaus showing the entrenched drainage and the characteristic denudation. At approximately 16°15' N, 49°30' E.

P-9. The Sogta Pass in Jabal Tuwaiq in central Arabia. At 24°30' N, 46°25' E.

P-10. Intensely di the plateau border in southern Palest 35°05' E.

P-14. Remnant of old plateau surface in the Upper Wadyan Province, southwestern Iraq. The Wadi Hauran traverses the area shown in the photo, flowing from left to right. At approximately 33°30' N, 41°40' E.

P-15. Jointing in well-bedded Cretaceous limestone on the north side of Wadi Hauran in southwestern Iraq. At approximately 33°40' 42°00' E.



rates of Jebel Syys, Jebel Druse volcanic region, Syria. At 33°25'N, 36°50'E.

P-5. Safa lava flood, Jebel Druse, Syria At 33°25'N, 36°50'E.

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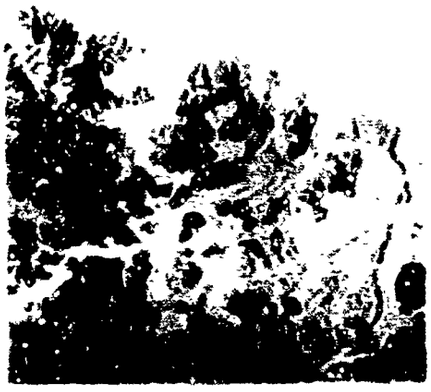


P-10. Intensely dissected edge of the plateau bordering the Wadi Arabe in southern Palestine. At 30°00' N, 35°05' E.

P-11. Looking up the Wadi Zerqa in the Jordan Plateau north of the Dead Sea. At approximately 32°10' N, 35°50' E.

nting in well-bedded Cretaceous on the north side of Wadi Hauran in ern Iraq. At approximately 33°40' N,

P-16. Erosional remnants in the Gaara Depression, southwestern Iraq. At approximately 33°30' N, 40°15' E.

ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS

PLAINS:

Plains are extensive tracts of land characterized by flat to gentle slopes. Hills may be found within plain regions but occupy less than 25 percent of the total area. Approximately 28 percent of the Middle East desert is occupied by plains. Plains may be subdivided on the basis of origin or physiographic relation. Floodplains, deltas, and terraces of major rivers are termed alluvial plains; plains bordering the sea, coastal plains; low-lying plains bounded on two or more sides by scarps, depression plains; and interior plains not readily classifiable into the other types, desert plains. Undissected plains exhibit relief ranging from approximately 0 to 10 ft. Relief within dissected plains would characteristically be between 10 and 50 ft and occasionally up to 100 ft. The composition of the plains of the Middle East desert varies widely. In the interior, vast plains of sedimentary and crystalline rocks are found. However, the majority of the plains are composed of unconsolidated material of which sand, gravel, silt, and salt are the most common. Most of the plains lie between the elevations of 0 and 1000 ft. A narrow coastal plain fringes the entire Arabian Peninsula. The plain ranges from several miles to as much as 40 miles in width and is occasionally interrupted where the adjacent highlands extend to the sea. Where the coastal plains lie in close proximity to the mountains

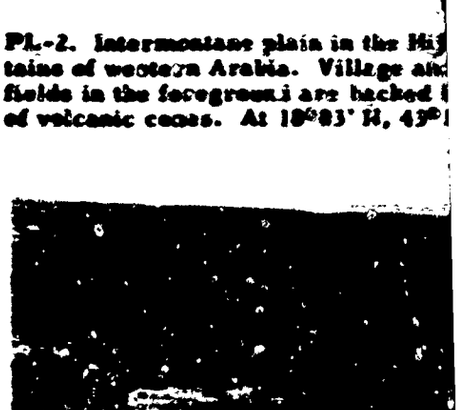
Reference 72

PL-1. The town of Mukalla on the narrow coastal plain of southern Arabia. At 14°33' N, 49°07' E.

PL-2. Intermontane plain in the Hi
tains of western Arabia. Village an
fields in the foreground are backed
of volcanic cones. At 18°83' N, 43°

Reference 72

PL-6. Saudi Arabian Mining Syndicate road passing through high lava plateau strewn with broken lava. At approximately 23°05' N, 40°20' E.



PL-7. Outcrop of gypsum exposed
face of the Al Jezire, a vast desert
between the Tigris and Euphrates R
approximately 34°30' N, 41°30' E

2
OGRAPHY: DESCRIPTIONS AND PHOTOGRAPHS

and plateaus they are highly dissected. Along the Hasa plain in eastern Arabia and in the southeast part of the peninsula, relatively undissected plains grade into interior plains which extend inland for great distances. Two depression plains are found in the Middle East desert: (1) the Dead Sea Trough which marks the eastern boundary of Palestine, and (2) the Wadi Sirhan in northwestern Arabia. Of the two the Wadi Sirhan is the larger, being some 200 miles in length and averaging some 20 miles in width. The Dead Sea Trough is approximately half this size. Characteristics of the two plains, however, are strikingly similar. Both are bounded on either side by high, steep scarps flanked by numerous alluvial fans and talus slopes. The floors of the depressions are generally sandy with numerous salt playas and patches of gravel. Both contain large areas of salt marsh. The Dead Sea Trough north of the Dead Sea is crossed by the Jordan River and bears little resemblance to the portion of the depression lying south of the sea. Only one alluvial plain has been mapped in the Middle East desert, that of the Tigris and Euphrates Rivers. The plain extends from north of Baghdad to the head of the Persian Gulf. The eastern limit of the floodplain is the break with the mountains of Iran. To the west the plain gradually rises until it merges with the dunes of the bordering desert plains

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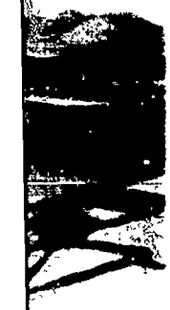
large number of intermittent
upon the level of the rivers.
vial origin characterize the pla
with differences in elevation ne
of the northern part of the stud
ders the Mediterranean mount
Iraq and south along the Pers
northwest to southeast: (1) th
(2) the Al Jazira, the desert pla
(3) Al Hajara, the st plain
(4) the Dibdibba, a flat, relati
Kuwait, and northeastern Arab
allels the Persian Gulf and me
Arabia a number of large sand
in southern Arabia flanks the
marks the transition between



Reference 28

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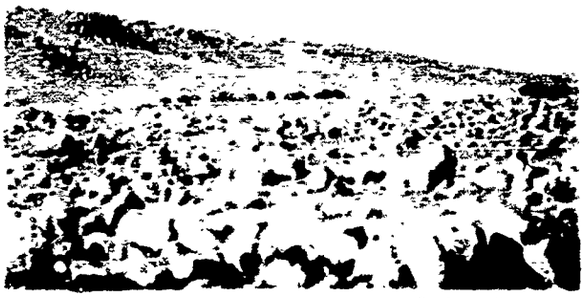


Dr. James G. Ba...

PL-3. North slope of the Faidhat Sa'atallah Depression south of Salum in southern Iraq. Possibly caused by solution. At 30°25' N, 44°25' E.

Ref...

PL-4. Jabal Madhra' ash Shamali, an iso... butte on the Dammam Dome in eastern Ara... Typical sabkha in the foreground. At 26°1... 50°05' E.

...mes G. Ba...

...n the sur-
...plain lying
...pers. At

Dr. James G. Ba...

PL-8. Sinkhole near Ain Wisa in the Lower Wasyan Province of southern Iraq. At 33°06' N, 45°40' E.

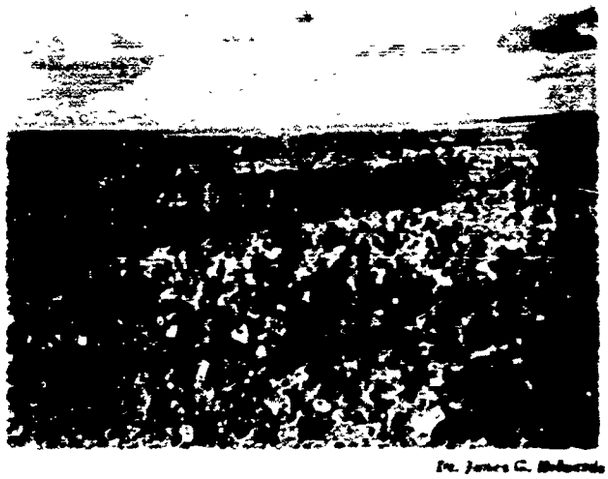
Dr. James G. Ba...

PL-9. Ain Aqta, an oasis in the Lower Wa... Province of southern Iraq. The trees sur-rounding the spring are date palms. At app...

or the escarpment of the Arabian tableland. Most of the plain is swa[illegible] a large number of intermittent freshwater lakes which vary greatly in s[illegible] depending upon the level of the rivers. Unconsolidated deposits of silt, sand, and clay of alluvial origin characterize the plain. The relief throughout the entire plain is very low with differences in elevation never exceeding a few feet. Desert plains occupy much of the northern part of the study area. Beginning with the Syrian Steppe, which borders the Mediterranean mountains to the west, the plains extend to the east across Iraq and south along the Persian Gulf in Arabia. The northern plains are, from northwest to southeast: (1) the Syrian Steppe, lying west of the Euphrates River, (2) the Al Jazira, the desert plain lying between the Tigris and the Euphrates Rivers, (3) Al Hajara, the stony plain of southern Iraq south of the Euphrates River, and (4) the Dibdibba, a flat, relatively undissected desert plain in southeastern Iraq, Kuwait, and northeastern Arabia. In east central Arabia the sandy Hasa plain parallels the Persian Gulf and merges with the central plateaus to the west. In central Arabia a number of large sand and gravel plains occur. A long, rolling desert plain in southern Arabia flanks the Hadhramaut Plateaus and the Oman Mountains and marks the transition between these highlands and the Rub' al Khali Desert.

Reference 39

-4. Jabal Madhra' ash Shamali, an isolated te on the Dammam Dome in eastern Arabia. ical sabkha in the foreground. At 26°18' N, 05' E.



Dr. James G. Ibbeken

PL-9. Stony surface typical of the Al Hajara Plateau Province in southern Iraq. At 30°40' N, 43°45' E.

Dr. James G. Ibbeken

-9. Ain Aqia, an oasis in the Lower Wadyan [illegible] of southern Iraq. The trees sur-

Dr. James G. Ibbeken

PL-10. The surface of the Al Hamad Plain in southeastern Iraq. At approximately 31°20' N,

PL-1. The town of Mukalla on the narrow coastal plain of southern Arabia. At 14°33' N, 49°07' E.

PL-2. Intermontane plain in
tains of western Arabia. Vill
fields in the foreground are h
of volcanic cones. At 18°03'

PL-6. Saudi Arabian Mining Syndicate road passing through high lava plateau strewn with broken lava. At approximately 22°05' N, 40°20' E.

PL-7. Outcrop of gypsum ex
face of the Al Jezira, a vast
between the Tigris and Euph
approximately 36°30' N, 43°

PL-11. Fortified town of Dura-Europus in the desert plains bordering the lower Euphrates in Iraq. Exact location unknown.

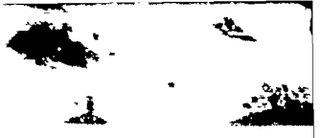
PL-12. The flat plains of
southern Iraq as viewed fr
Season. At 30°25' N, 47°4

4

* Reference numbers refer to similarly numbered entries in the bibliography at the end of volume I

the Hijaz Moun-
lage and cultivated
backed by a number
N, 43°12' E.

PL-3. North slope of the Fa'idat Sa'atullah Depression south of Salum in southern Iraq. Possibly caused by solution. At 30°25' N, 44°25' E.



PL-4. Jabal Madhra' ash Shamali butte on the Dammam Dome in eas Typical sabkha in the foreground. 50°95' E.

xposed on the sur-
desert plain lying
rates Rivers. At
30' E.

PL-8. Sinkhole near Ain Wiza in the Lower Wadyan Province of southern Iraq. At 33°06' N, 42°40' E.

PL-9. Ain Aqia, an oasis in the Lo Province of southern Iraq. The tre rounding the spring are date palms imately 33°20' N, 43°04' E.

Ad Dibdibba in
rom the top of Jabal
5' E.

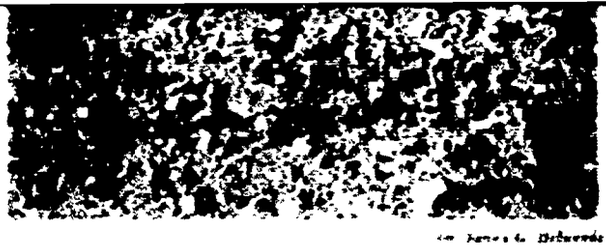
PL-13. Al Umchaimin Depression in southwestern Iraq, the crater is approximately 2 miles in diameter and is, supposedly, of meteoric origin. At 32°35' N, 39°25' E.

PL-14. The vast flood plain of the Ti south of Baghdad. At approximately 3 44°35' E.

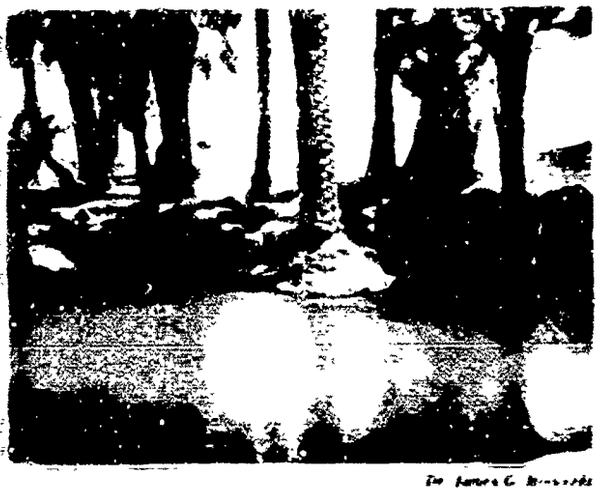
of this report

5

PL-4. Jabal Madhra' ash Shamali, an isolated butte on the Dammam Dome in eastern Arabia. Typical sabkha in the foreground. At 26°18' N, 50°05' E.

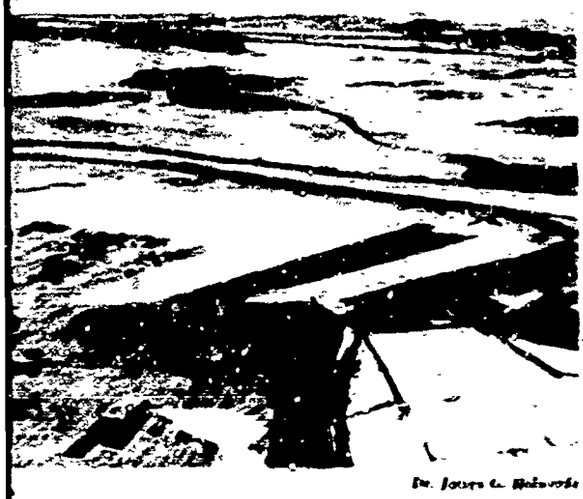


PL-5. Stony surface typical of the Al Hajara Plateau Province in southern Iraq. At 30°49' N, 43°45' E.

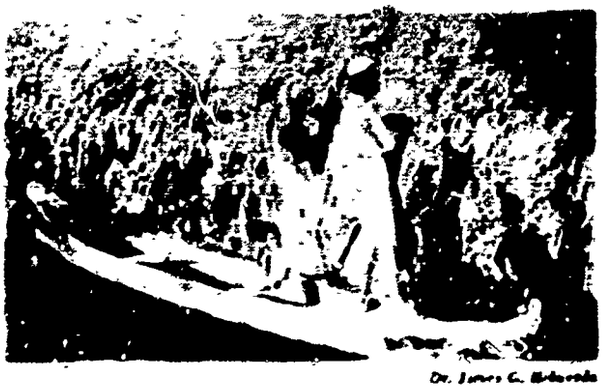


PL-9. Ain Aqis, an oasis in the Lower Wadyan Province of southern Iraq. The trees surrounding the spring are date palms. At approximately 33°20' N, 43°00' E.

PL-10. The surface of the Al Hamad Plain in southwestern Iraq. At approximately 33°20' N, 40°00' E.



L-14. The vast flood plain of the Tigris River uth of Baghdad. At approximately 33°10' N, 0°35' E.

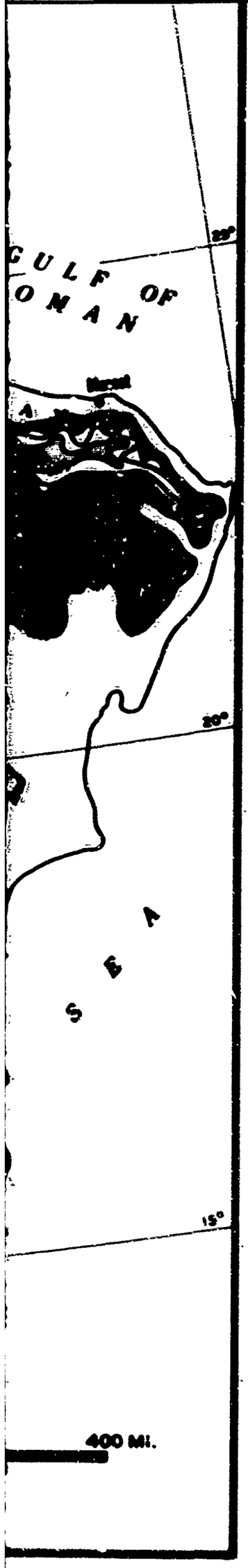


PL-15. Marsh in the southern part of the Tigris-Euphrates Delta Plain. At approximately 30°50' N, 47°30' E.

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

4 PHYSIOGRAPHY

DESCRIPTIONS AND PHOTOGRAPHS



HYPSOMETRY

1
2
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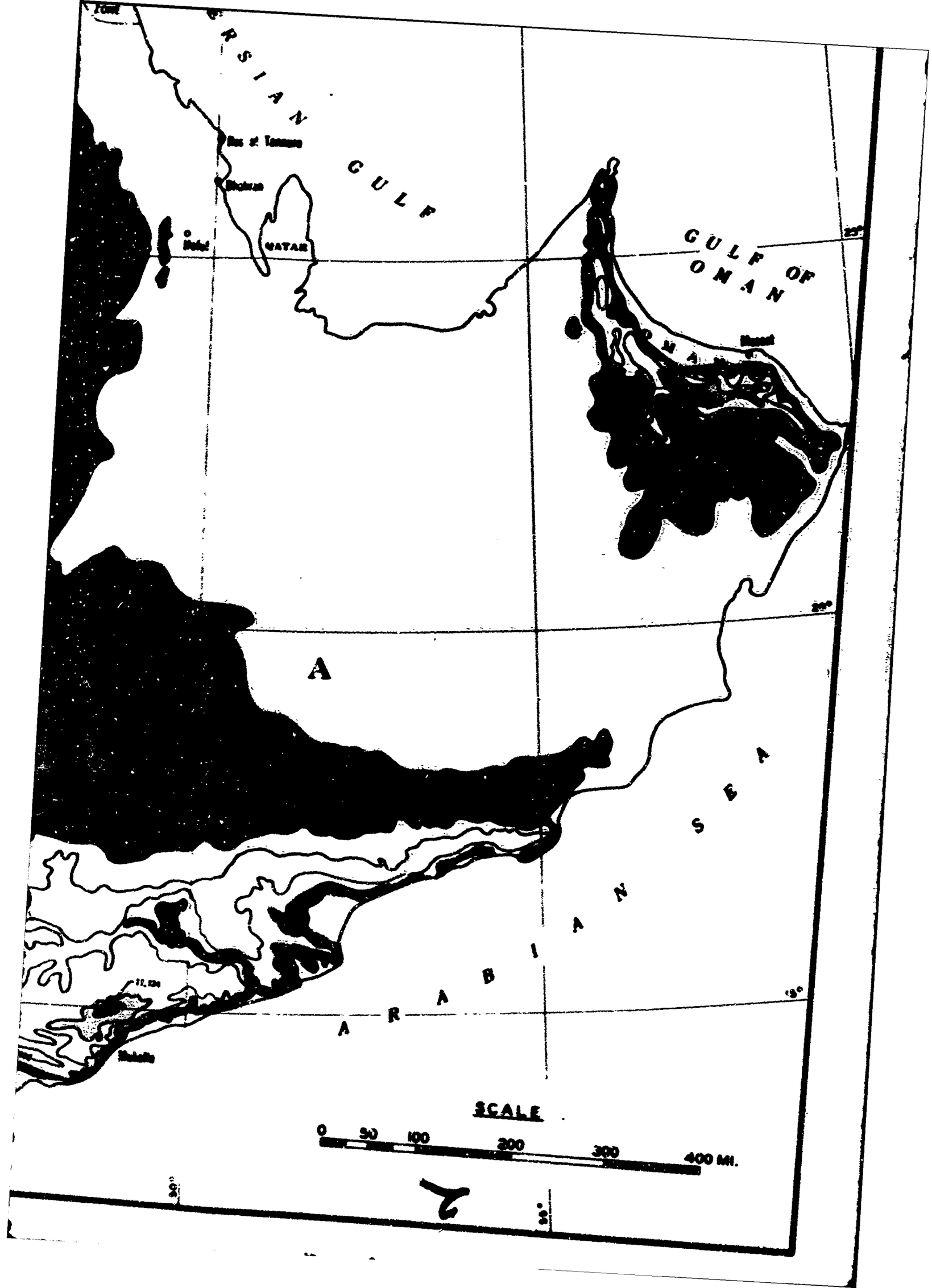
8

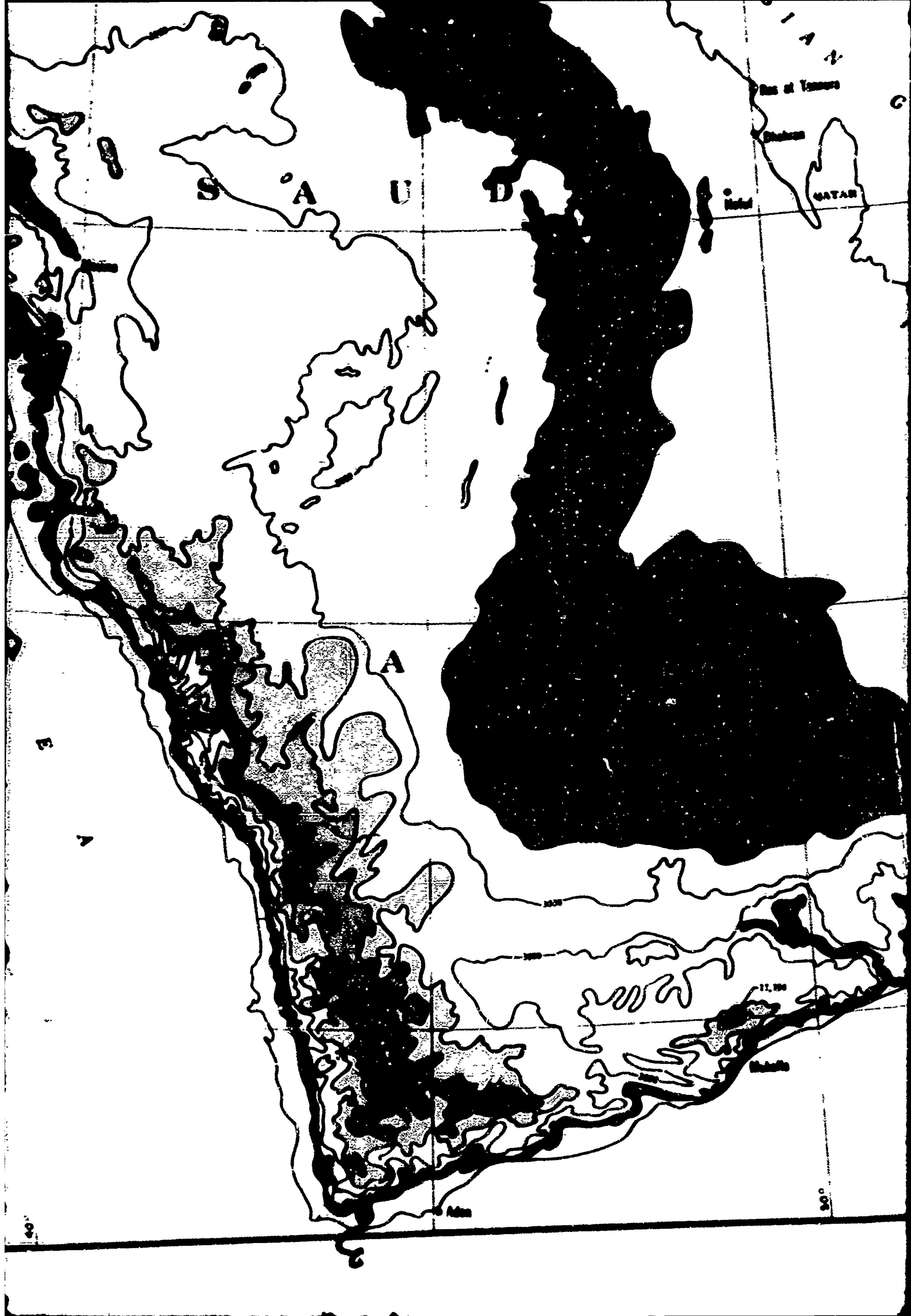
ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

HYPSOMETRY

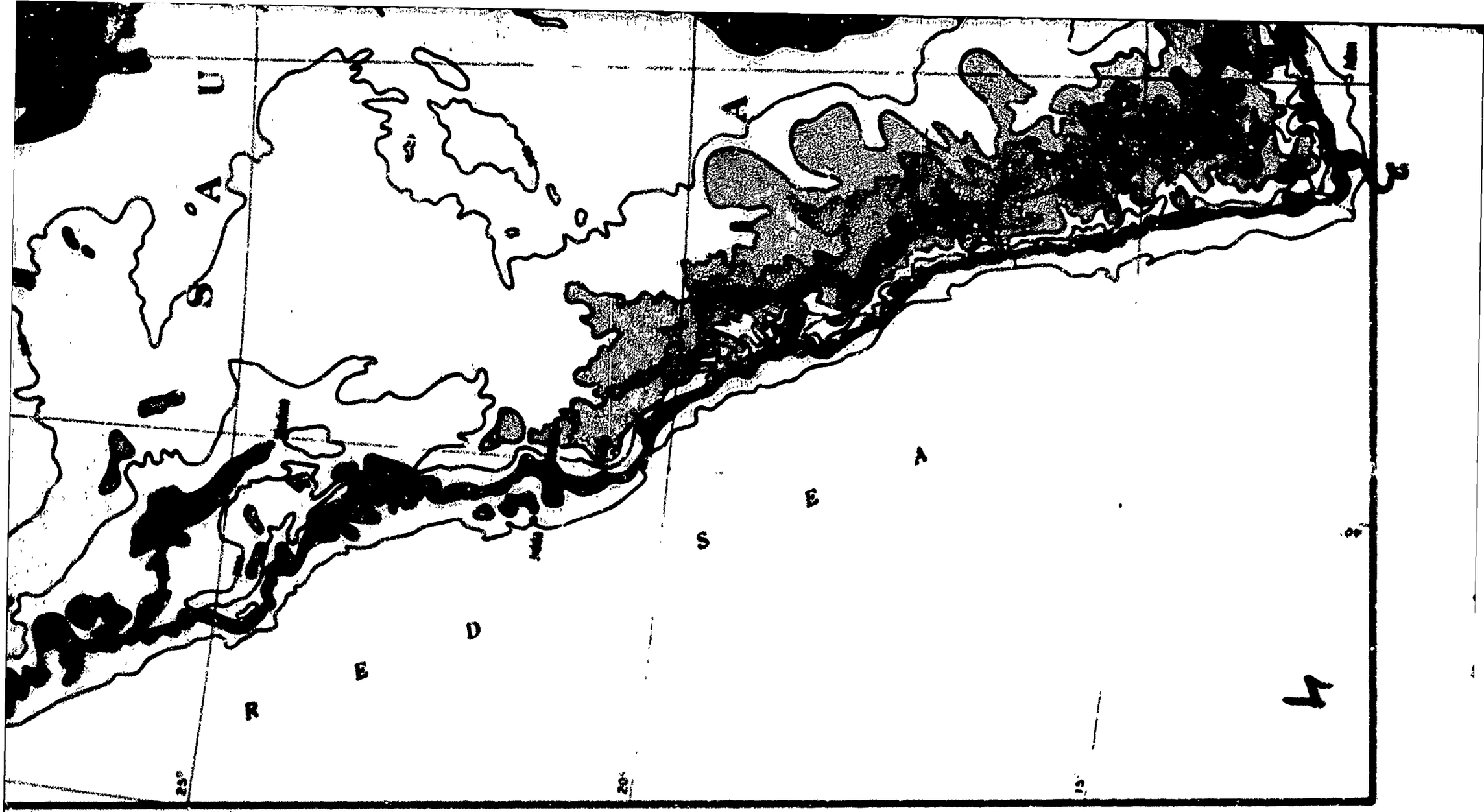
1

PLATE 10


PERSIAN GULF
Ras al Tannura
Dhahran
Bahrain
QATAR
GULF OF OMAN
Muscat
OMAN
ARABIAN SEA
SCALE
0 50 100 200 300 400 MI.



Ras at Tanura
Dhahran
Hofuf
QATAR
S A U D
A
Mukalla
Aden


S A U D I
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29°
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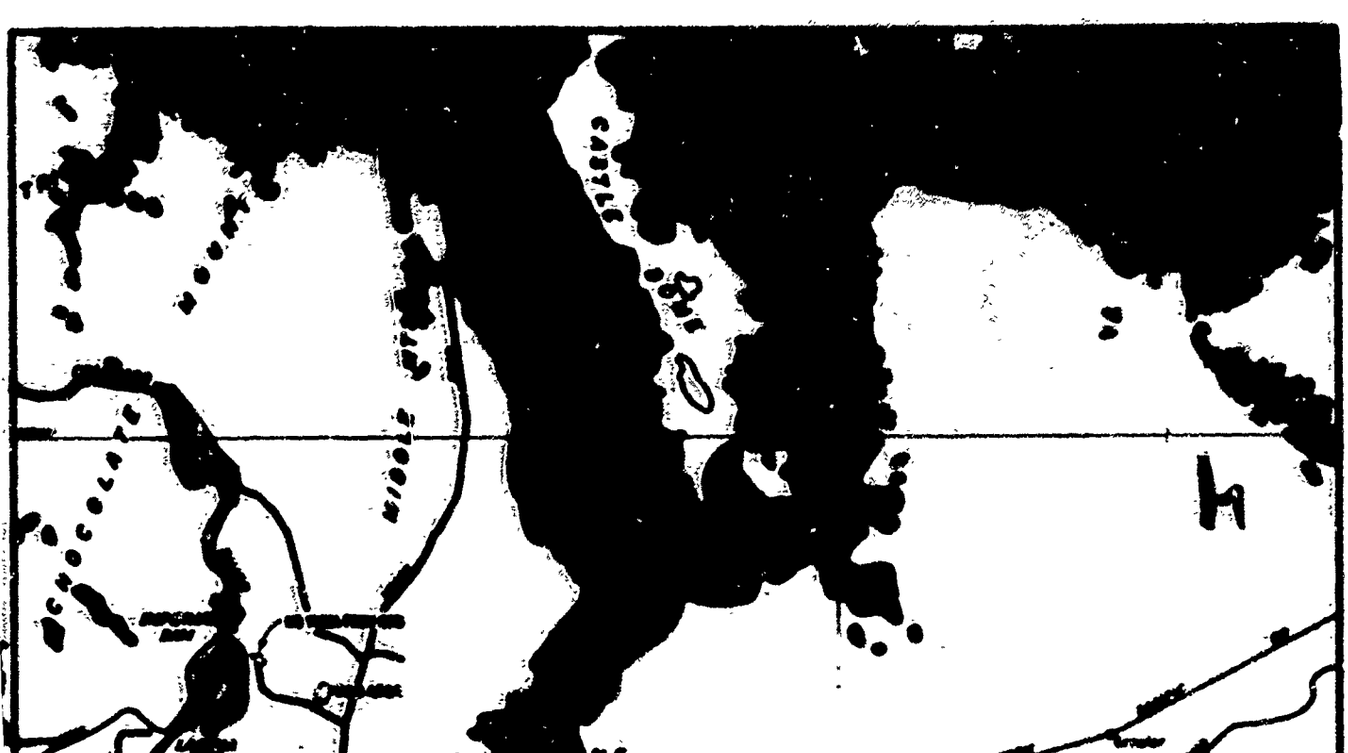
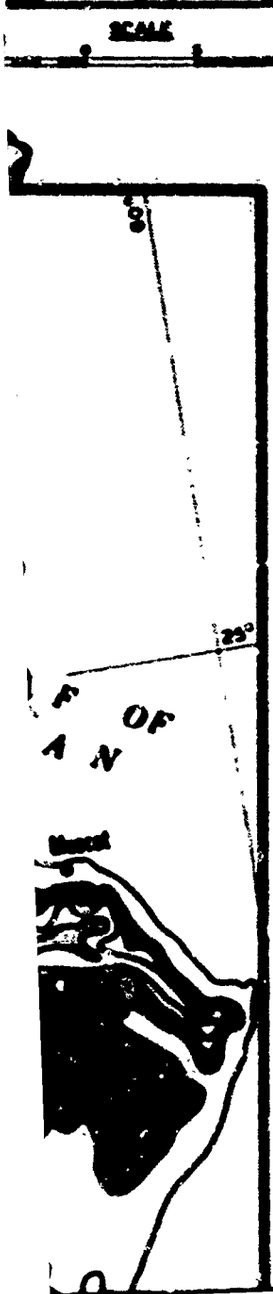
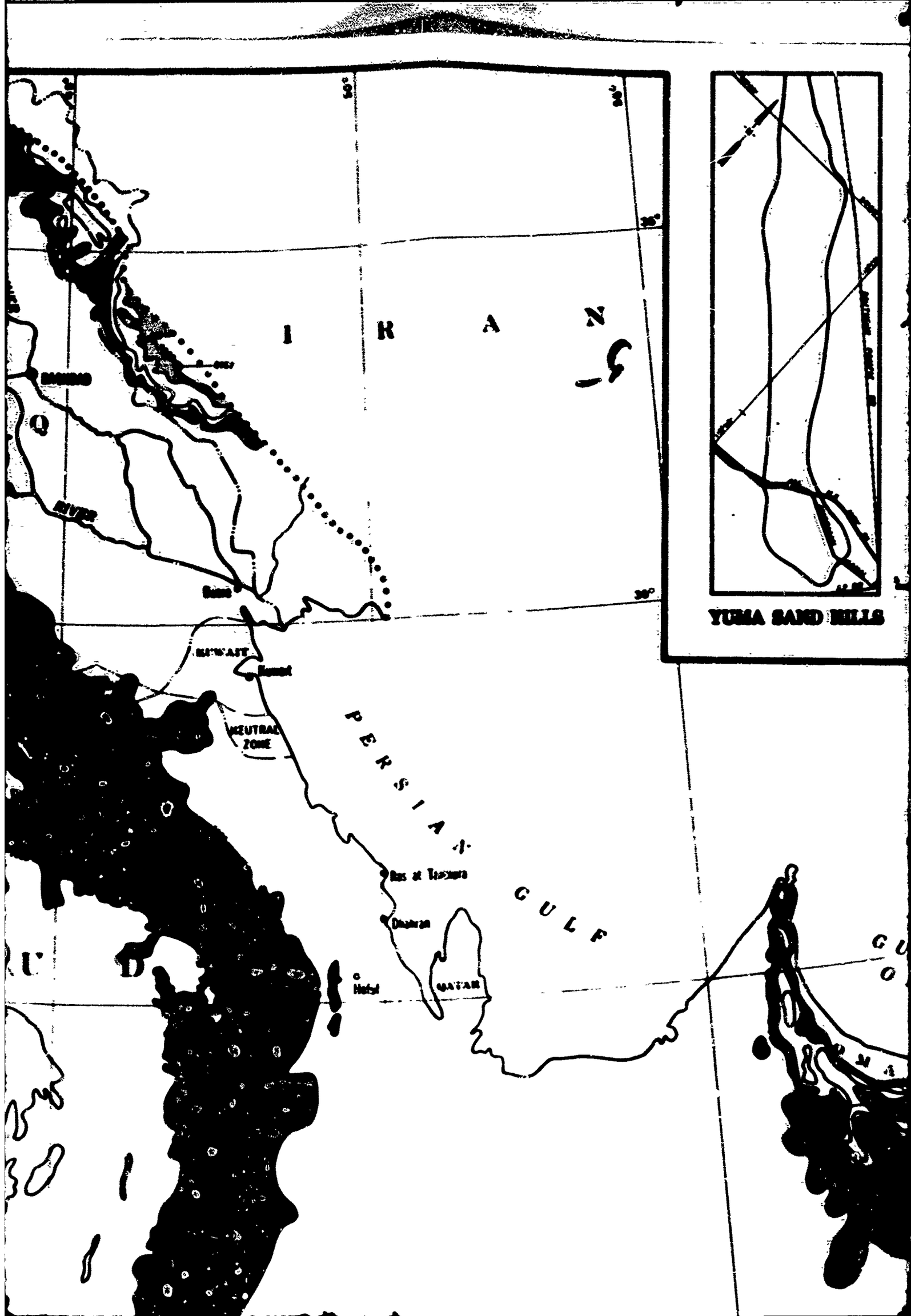
27°



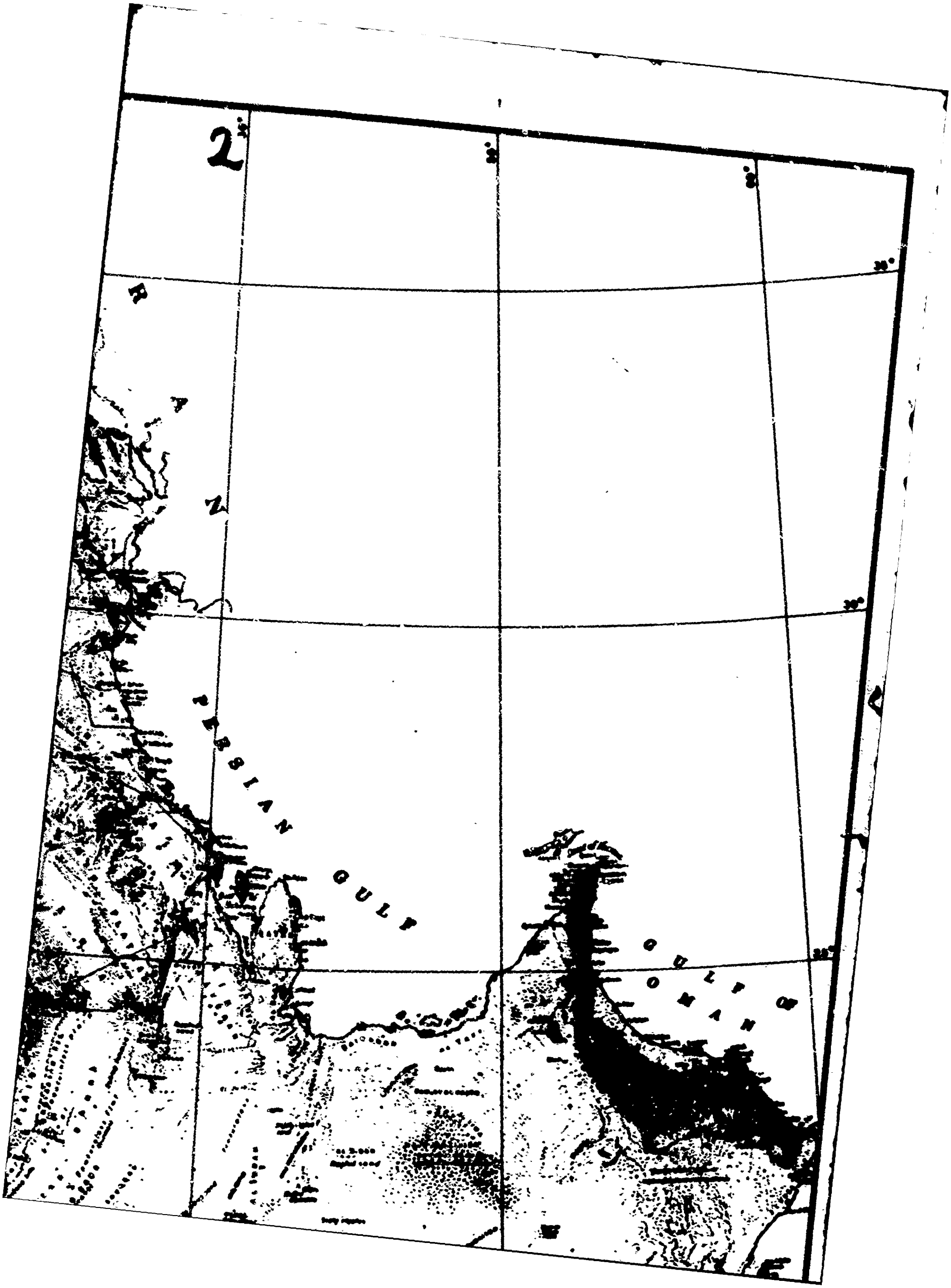
YUMA PROVING GROUND

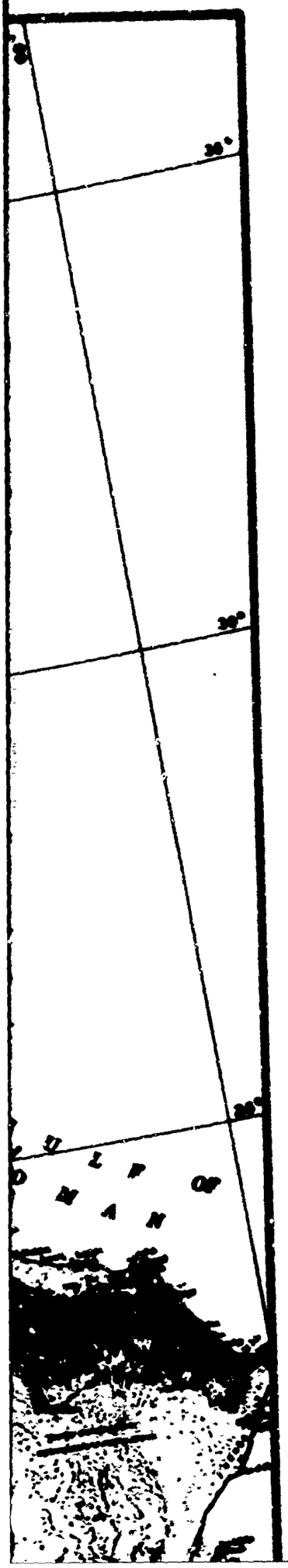



I R A N
PERSIAN GULF
KUWAIT
NEUTRAL ZONE
Ras al Tannurah
Dhahran
Hofuf
QATAR
YUMA SAND HILLS

MEDITERRANEAN SEA
EUPHRATES
TIGRIS
RIVER


MEDITERRANEAN
SEA
R
E
D

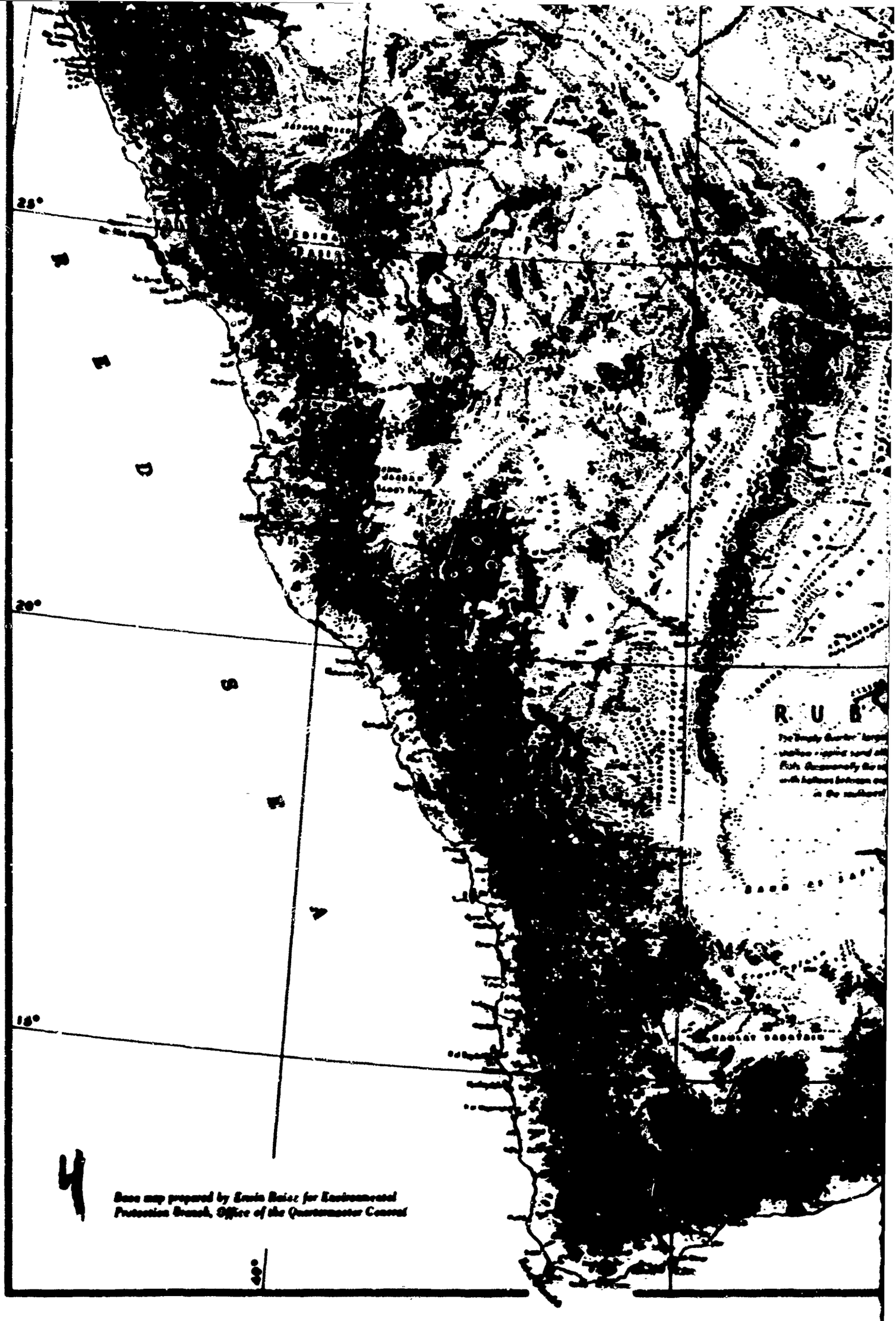

PERSIAN GULF
OMAN



3

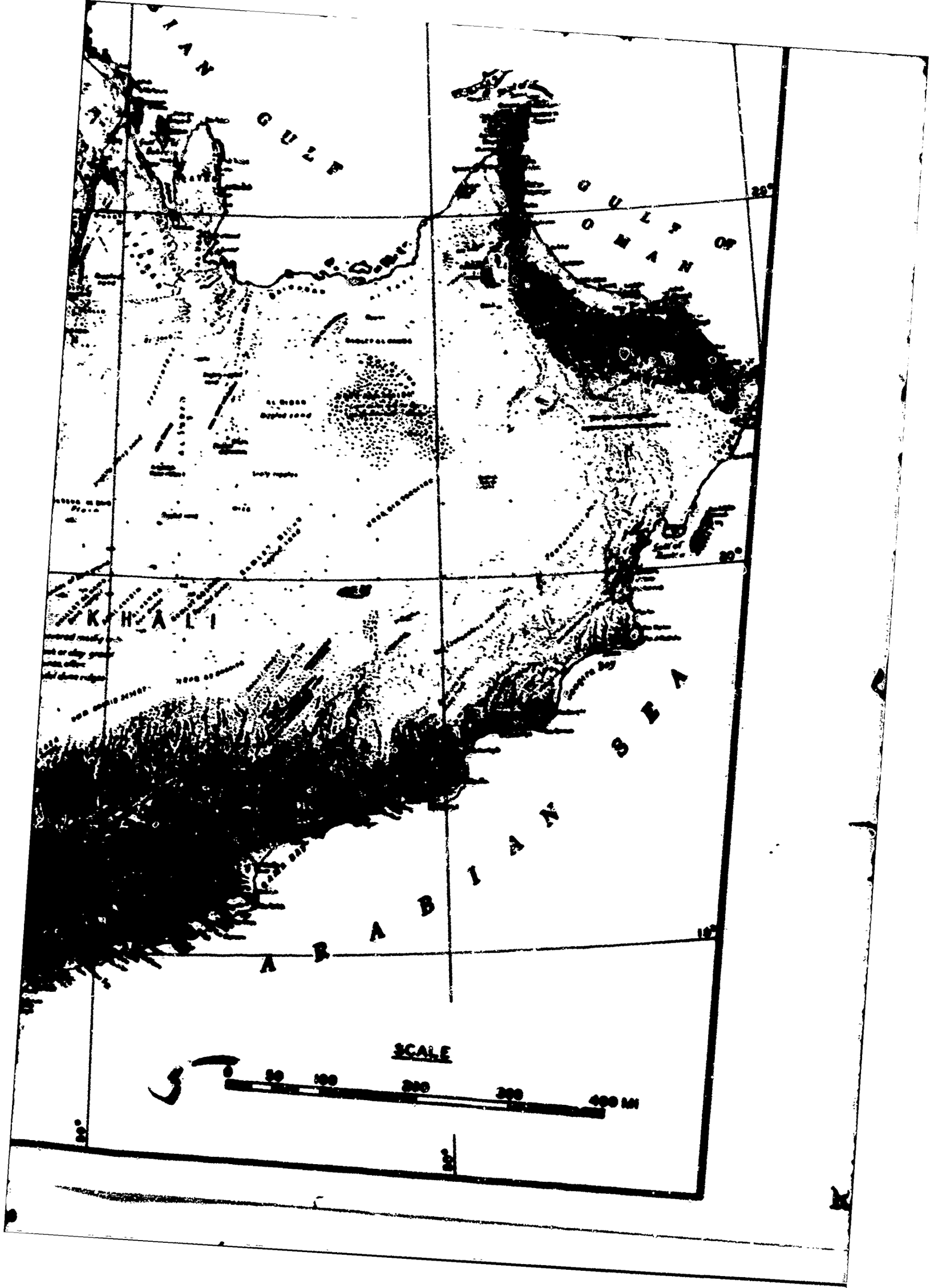
SOUTHWESTERN UNITED STATES

Reproduced from Map of the Landforms of the United States by Permission of Rand McNally and Co.



4

Base map prepared by Louis Baier for Environmental Protection Branch, Office of the Quartermaster General


GULF
OMAN
KHALI
ARABIAN SEA
SCALE
50
100
200
300
400 MI

ANALOGS OF YUMA TERRAIN

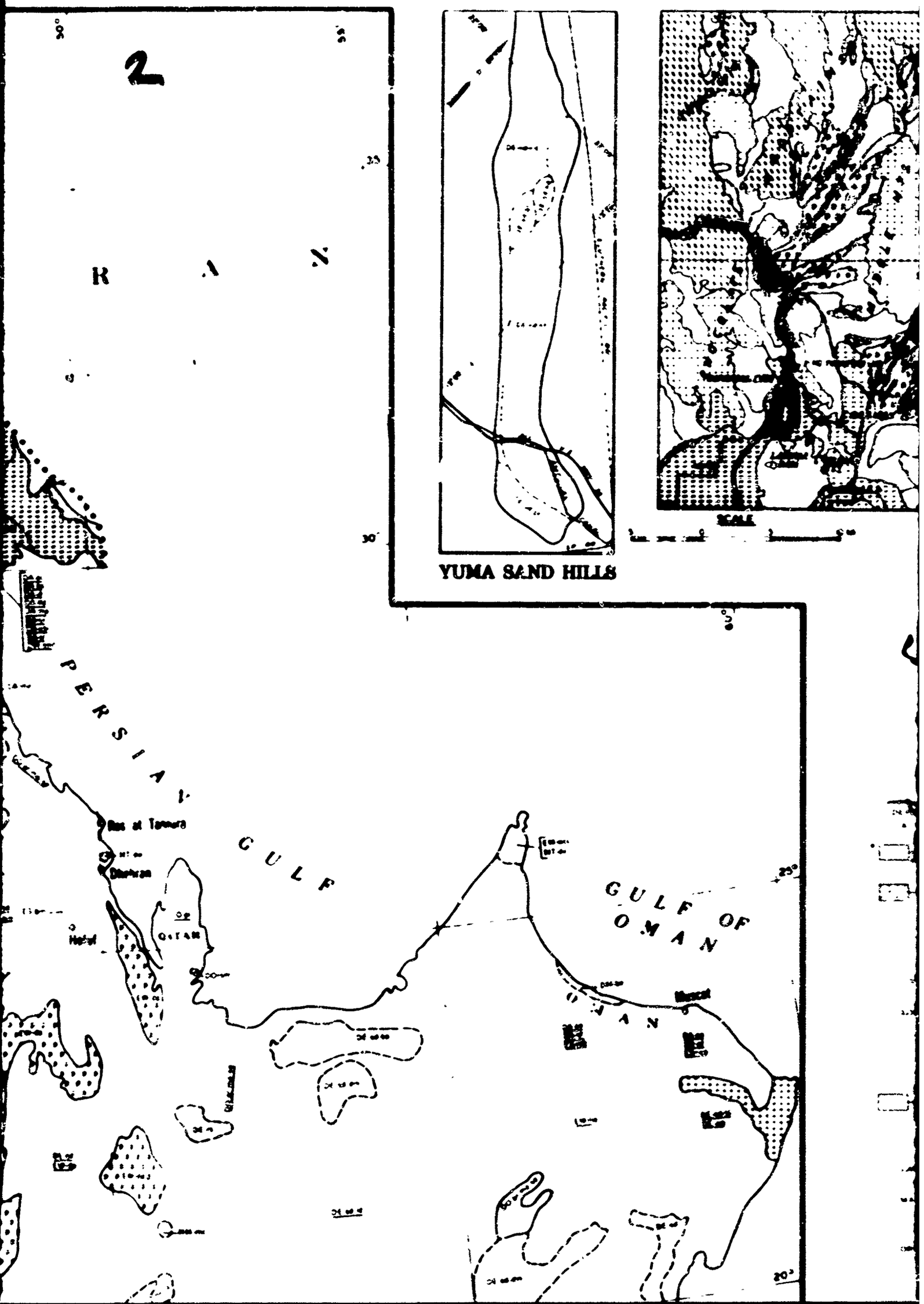
IN THE

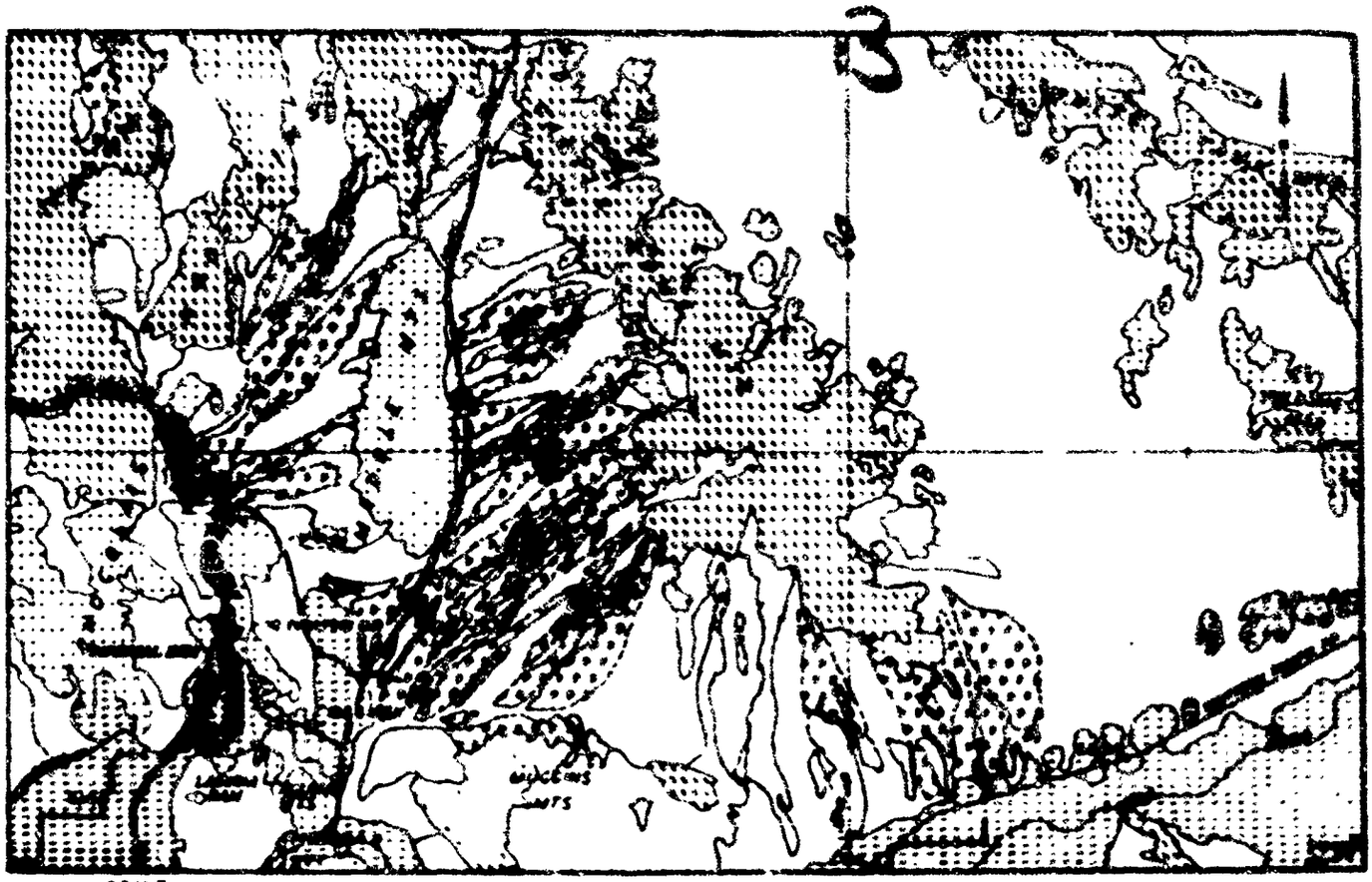
MIDDLE EAST DESERT

RAISZ'S LANDFORM MAP

PLATE 17

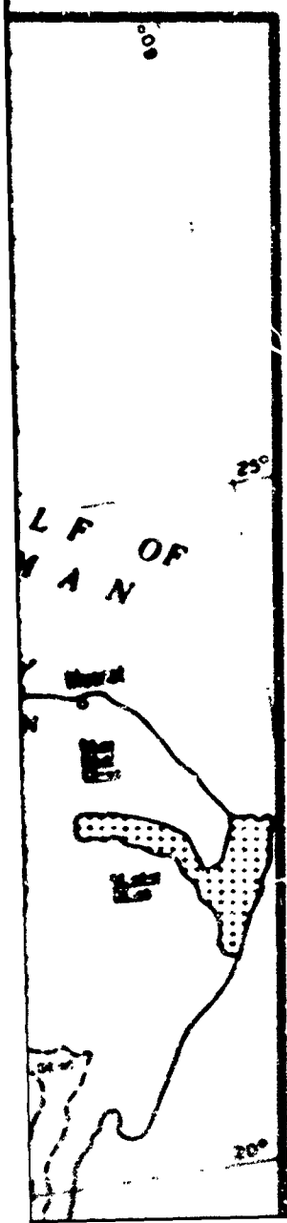
MEDITERRANEAN SEA
ALEPPO
SYRIA
BEIRUT
DAMASCUS
LEBANON
ISRAEL
JORDAN
JERUSALEM
Amman
Aqaba
RIVER
EUPHRATES
NEUTRAL ZONE
SAUDI
RED SEA

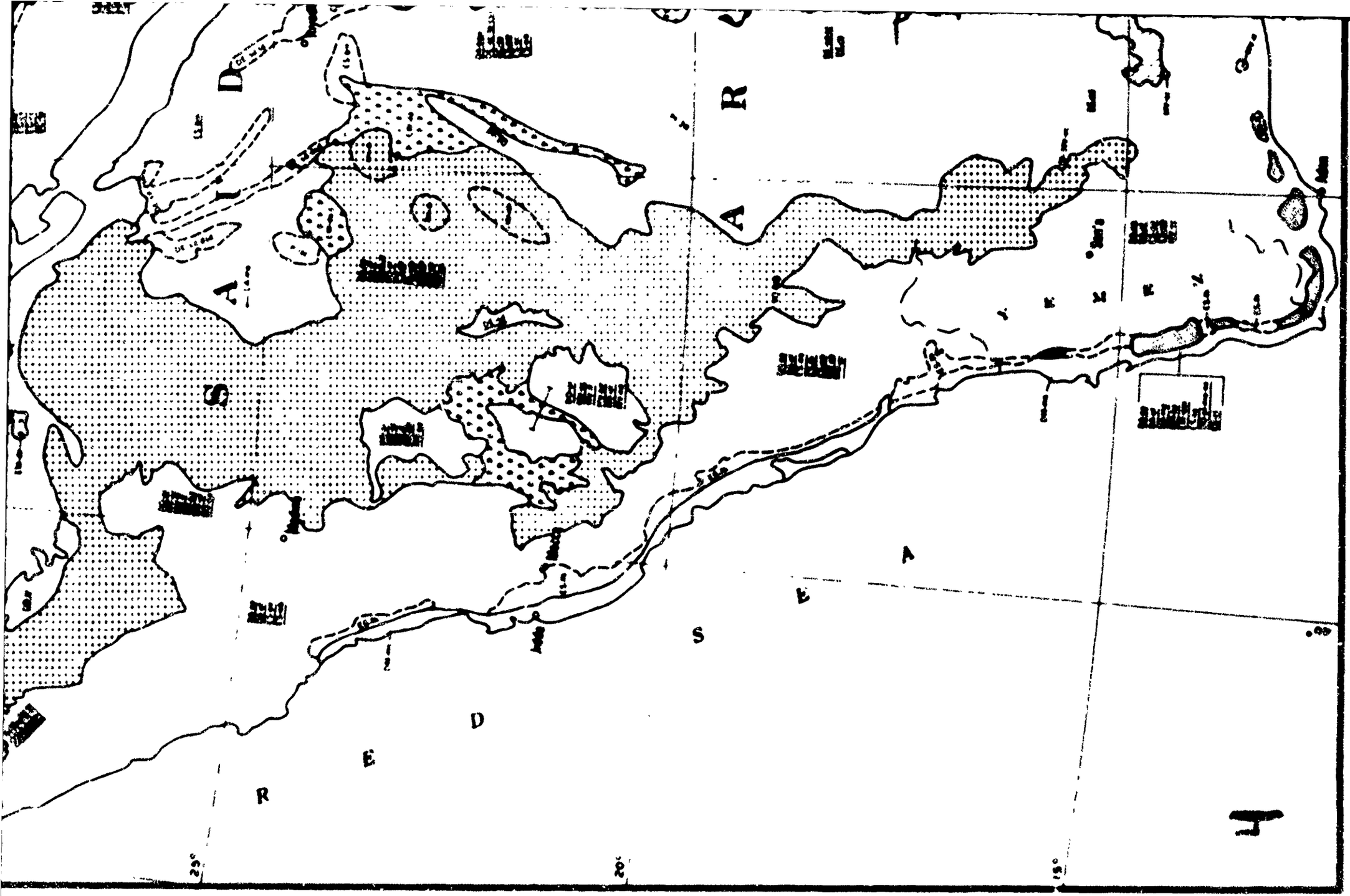

2
R A N
YUMA SAND HILLS
SCALE
PERSIAN GULF
GULF OF OMAN
OMAN
QATAR



SCALE

YUMA PROVING GROUND




R
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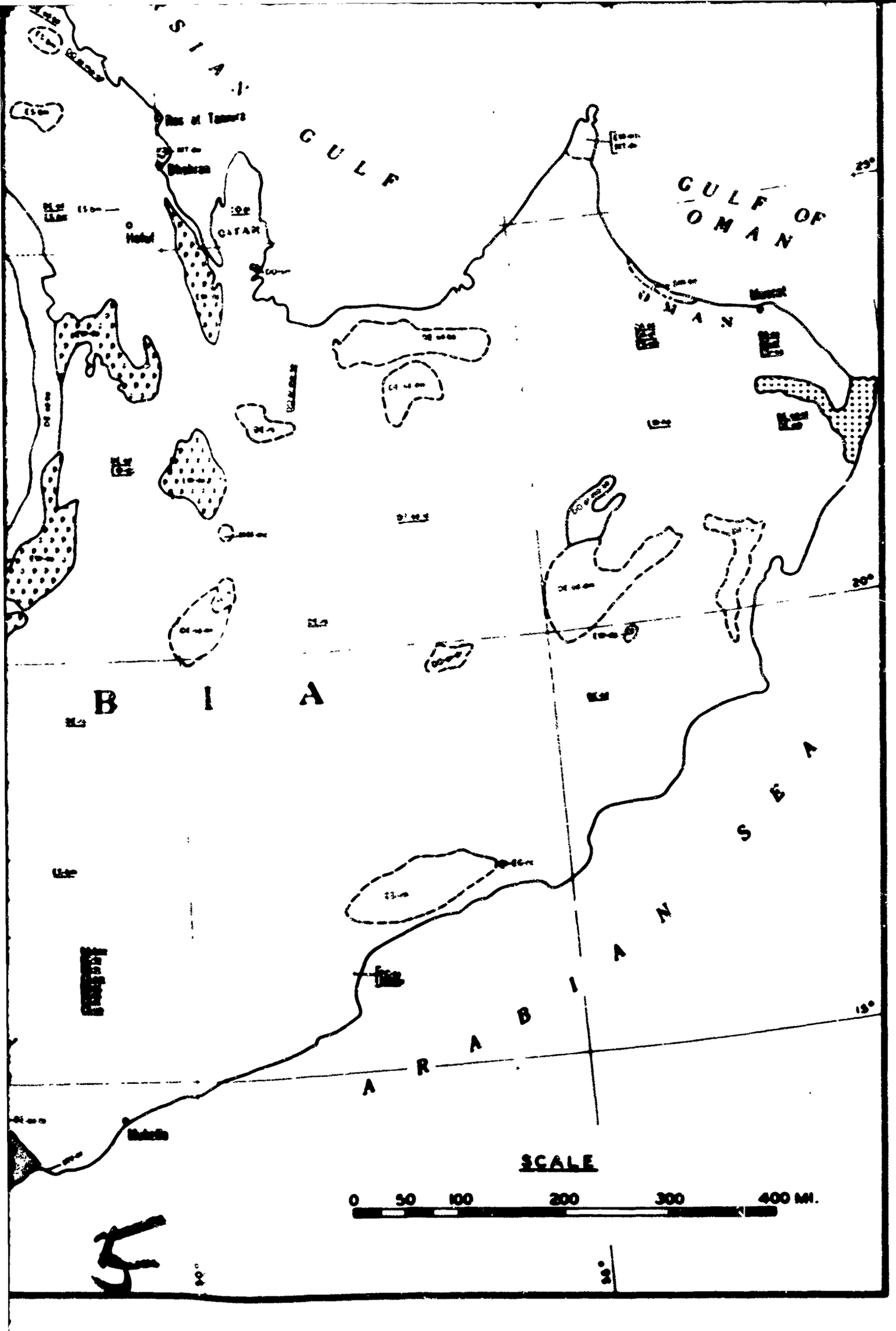
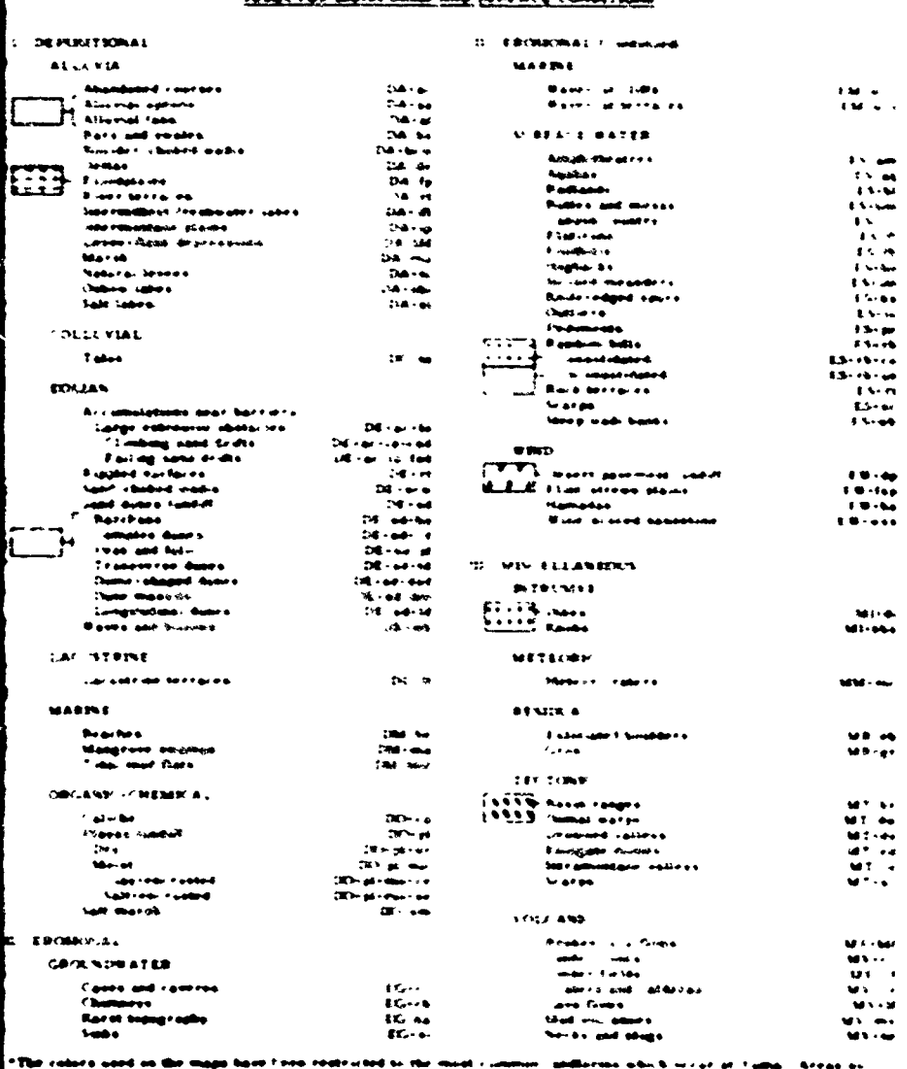
A


GULF
GULF OF OMAN
OMAN
QATAR
Doha
Ras al Tannurah
Dhahran
Hofuf
B I A
ARABIAN SEA
SCALE
0 50 100 200 300 400 MI.



ANALOGS OF YUMA TERRAIN IN THE MIDDLE EAST DESERT

SELECTED LANDFORMS AND SURFACE CONDITIONS

PLATE 18

Photo No.	CLASSIFICATION AND DESCRIPTION
	1. DEPOSITIONAL **ALLUVIAL**
1	Abandoned courses: Abandoned courses are lengthy segments of a river abandoned when the stre a new course across the floodplain.
2	Alluvial aprons. Alluvial aprons are created through coalescence of alluvial fans along the base or plateau escarpments. Several fans coalesce to form an alluvial apron.
3	Alluvial fans Alluvial fans are cone-shaped features occurring at the base of mountains, hills, etc., where streams experience a sufficient reduction in gradient to deposit their loads. steepest near the mountains, slope gently outward with a continually decreasing gradien characterized by braided stream channels which score their surfaces.
4	Bars and swales: Bars and swales are accretion deposits formed on the insides of river bends, wherever the channel migrates. Sandy bar deposits or "ridges" are laid down during the river and, as the water subsides, an accurate depression or "swale" often flanks th landward side. The swale is modified by subsequent high-stage flow and eventually is river continues to migrate. The depression is gradually filled with fine-grained mater ternating series of sandy ridges and clayey swales results, conforming to the curvature grating channel.
5	Boulder-choked washes: Boulder-choked washes are relatively narrow and deep, intermittent str generally in mountainous or plateau regions, where boulders have been amassed in num cient to retard or prevent vehicular movement.
6	Deltas. Deltas are alluvial tracts of land, usually triangular in shape, formed at the mouth of a r boundaries of deltas often, but not invariably, coincide with the farthest upstream distrit of a river.
7	Floodplains: Floodplains are relatively smooth, flat lands bordering a stream. They are built o deposited by the stream and inundated by floodwaters.
8	River terraces: River terraces are flat stripe of land bordering river floodplains. They are ch by a sharp descent toward the river and by more elevated land on the opposite side. A arrangement of several terraces often flanks larger floodplains.
9	Intermittent freshwater lakes: Intermittent freshwater lakes are standing bodies of inland fresh which become dry during certain periods of the year.
10	Intermontane plains: Basins of interior drainage between mountain ranges composed of fine-gra deposited by streams issuing from the adjacent mountains.
11	Levee-flank depressions: Levee-flank depressions are irregular to rectilinear low areas, usual ponds or lakes, paralleling and flanking natural levee ridges. They are best developed regions.
12	Marsh: Marsh is a tract of low (in reference to surrounding terrain), wet ground, usually dairy with rank grass and sedge vegetation and confined to freshwater areas.
13	Natural levees: Natural levees are long, relatively narrow alluvial ridges, higher near the river ually sloping away from it, which are built up on either side of a stream by overbank flo drainage patterns range from minute drainageways to major crevasses, commonly foun angles to the direction of levee elongation.
14	Ox-bow lakes: Ox-bow lakes are crescent-shaped lakes formed when rivers are shortened by th of migrating river bends at the upstream and downstream arms of meander loops.

• Not applicable.

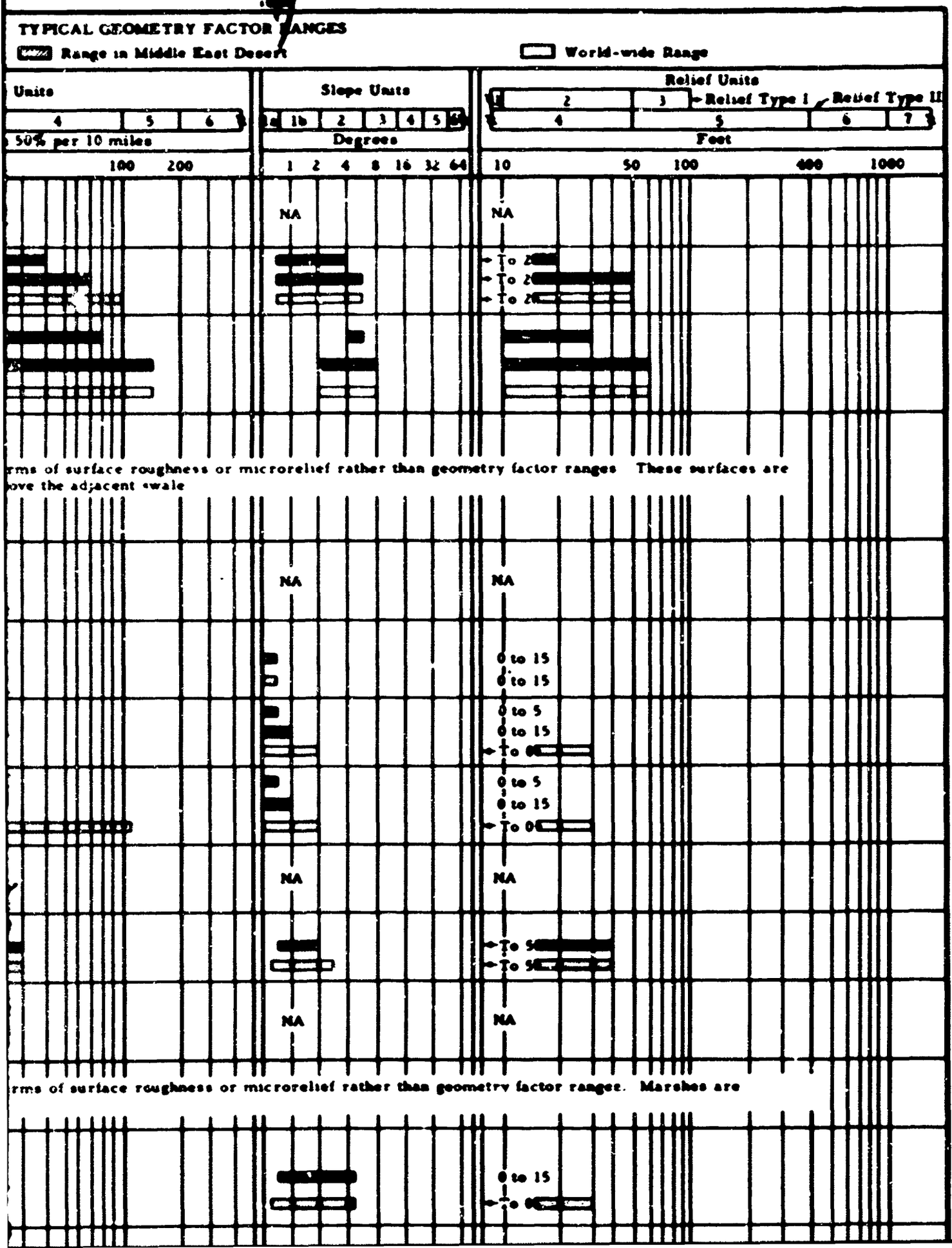
RFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRAPHS

TYPICAL GEOMETRY FACTOR RA

Range at Yuma Range in Middle East Desert

	Plan-Profile Units	Slope Occurrence Units Number of slopes greater than 50% per 10 miles 1 | 2 | 3 | 4 | 5 | 6 1 5 20 100 200
oses	NA	NA
tains	1L, 7 1, 1L, 7 1, 1L, 7	To 0 To 0
eaus, fans, e	1L 1, 1L 1, 1L	
ges of on the as the an al- mi-	This phenomenon is classed as a surface condition and considered in terms of surface roughness or microre rolling in nature, with the crest of the bars ranging from 2 to 10 feet above the adjacent swale.	
ds, ffi-	NA	NA
Inland s	7 7	Lacking Lacking
ents	7 7 7, 1, 1L	Lacking To 0 To 0
ized	7 7, 1 7, 1	Lacking To 0 To 0
	NA	NA
ligvium	7, 1, 1L 7, 1, 1L	To 0 To 0
taining taic	NA	NA
vered	This phenomenon is classed as a surface condition and considered in terms of surface roughness or micro characteristically featureless.	
grad- urface ight	NA NA	NA NA
lescence	NA	NA

PHOTOGRAPHS



7	deposited by the stream and inundated by floodwaters
8	River terraces. River terraces are flat strips of land bordering river floodplains by a sharp descent toward the river and by more elevated land on the opp arrangement of several terraces often flanks larger floodplains.
9	Intermittent freshwater lakes Intermittent freshwater lakes are standing bodies which become dry during certain periods of the year
10	Intermontane plains Basins of interior drainage between mountain ranges compo deposited by streams issuing from the adjacent mountains.
11	Levee-flank depressions. Levee-flank depressions are irregular to rectilinear i ponds or lakes, paralleling and flanking natural levee ridges. They are regions.
12	Marsh Marsh is a tract of low (in relation to surrounding terrain), wet ground with rank grass and sedge vegetation and confined to freshwater areas
13	Natural levees Natural levees are long, relatively narrow alluvial ridges, highe ually sloping away from it, which are built up on either side of a stream drainage patterns range from minute drainageways to major crevasses, angles to the direction of levee elongation.
14	Ox-bow lakes. Ox-bow lakes are crescent-shaped lakes formed when rivers are of migrating river bends at the upstream and downstream arms of mea

* Not applicable.

†† Raised numbers refer to similarly numbered entries in the bibliography at the end o

1. A vertical photograph showing the now heavily vegetated meander of an abandoned course in the lower left quarter of the photograph

2. An alluvial apron forming a narrow, continuous band between the background mountains and the basin in the lower half of the photograph

3. A ver an alluvi

9 Intermittent freshwater lakes

10. Intermontane plain as viewed from adjacent mountains

11. Wa depress

...e characterized ... A steplike	7 [illegible] 7, 1	Lacking [illegible] To 0[illegible]	
...fresh water	NA	NA	
...-grained alluvium	[illegible] 1, 1L [illegible] 1, 1L	To 0[illegible] To 0[illegible]	
...usually containing ...loped in deltaic	NA	NA	
...mity and covered	This phenomenon is classed as a surface condition and considered in terms of surface roughness... characteristically featureless		
... river and grad- ...ank flow. Surface ... found at right	NA NA	NA NA	
...d by the coalescence ...s.	NA	NA	

...of this report

...tograph of

4. Vertical photograph of bar and swale topography. The bars are the light arcuate areas, the swales the intervening dark, vegetated areas

5. Boulder-choked wadis

6. Present distributary sy... the Mississippi River D...

...l levee-flank

12. Marsh

13. Cultivation on natural levees

14. A vertical photograph ...bow lake -- False River C... Louisiana.

		0 to 15	
		To 0	
		0 to 5	
		0 to 15	
		To 0	
NA		NA	
		To 5	
		To 5	
NA		NA	
		0 to 15	
		To 0	
NA		NA	

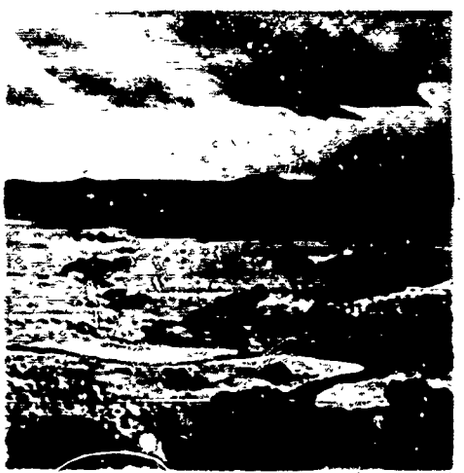
rms of surface roughness or microrelief rather than geometry factor ranges. Marshes are

U. S. Army Engineer District, New Orleans

Present distributary system of Mississippi River Delta

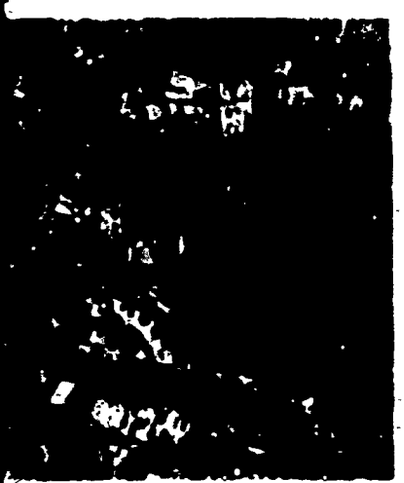
Reference 44

7. Floodplain of the Colorado River, looking southward from Laguna Dam, Arizona



H. E. Gregory, USGS[83]

8. Valley of Sevier River near Hatch, Utah, showing meanders and terraces



U. S. Army Corps of Engineers

A vertical photograph of an oxbow -- False River Cutoff, [illegible].

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

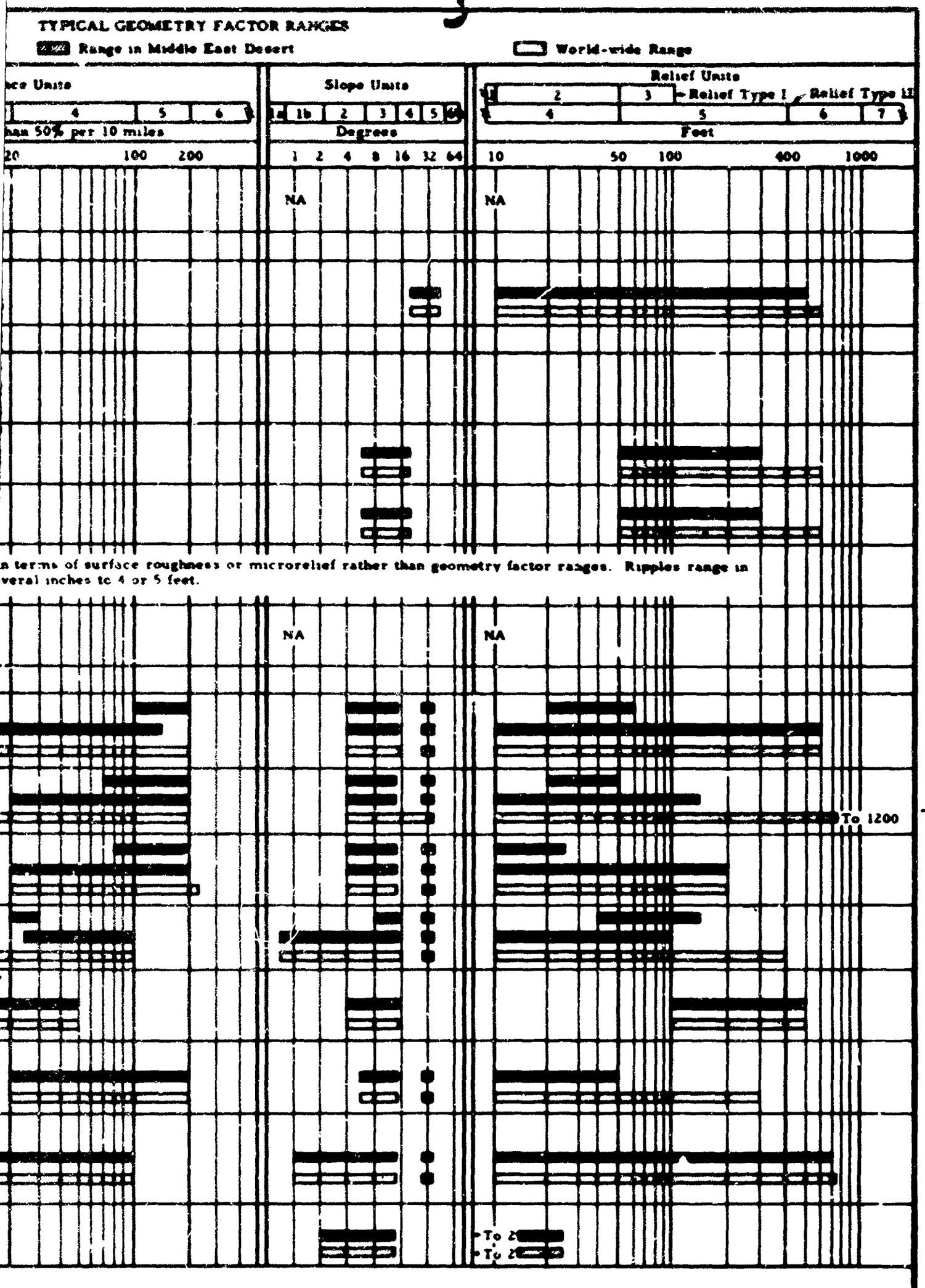
DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	I. DEPOSITIONAL (CONT.)
	ALLUVIAL
15	Salt lakes Salt lakes are permanent or intermittent bodies of saline water, generally of Surface evaporation of water exceeds inflow, thus creating saline conditions.
	COLLUVIAL
16	Talus. Talus is an unconsolidated, sloping heap of fairly large rock fragments or debris an escarpment or steep slope through gravitational accumulation.
	EOLIAN
	Accumulations near barriers
	Large extensive obstacles
17	Climbing sand drifts: These are massive accumulations of windblown sand which for extensive obstacles such as plateau scarps, hills, and mountains.
18	Falling sand drifts: Falling sand drifts are massive accumulations of windblown sand ward of extensive obstacles such as plateau scarps, hills, and mountains.
19	Rippled surfaces: Washboard-like surfaces caused by the heaping of sand by wind actio found on the gentler slopes of dunes or in flat, sandy areas.
20	Sand-choked wadis Sand-choked wadis are intermittent streambeds generally within plain areas which have been almost completely or partially filled with windblown sand
	Sand dunes: Mobile heaps of windblown sand independent of fixed objects or underlying top
21	Barchans: Barchans are dunes having a crescentric ground plan with the convex side f extending leeward. The profile is asymmetric with the gentler slope on the steeper slope on the concave or leeward face.
22	Complex dunes Complex dunes are irregular masses of sand not readily classifiable i
23	Peak and fuji: These occur where the tips or horns of a fast-moving barchan join or in side of another barchan, thus forming a circular or horseshoe-shaped hollow crest of the barchan slipface which flanks the fuji is referred to as the peak.
24	Transverse dunes: Transverse dunes are strongly asymmetric ridges extending transv dominant sand-moving winds. The leeward slope is steep; the windward, comp
25	Dome-shaped dunes: Dome-shaped dunes, formed as a result of highly varying wind dir broad circular upwarps. Barchan dunes often constitute the secondary surface dome-shaped dunes.
26	Dune massifs: Dune massifs are massive, roughly conical or pyramidal dunes characte Small hollows and terraces often dimple their steep sides. The massifs are u longitudinal dunes, but are quite unmistakable as they rise far above the gener
27	Longitudinal dunes Longitudinal dunes usually consist of a single continuous ridge whic at regular intervals to form a chain of summits connected by a continuous wavy is asymmetric with one side exhibiting a moderate slope, the other, a steep or nal dunes are aligned parallel to dominant sand-moving winds
28	Waves and billows Waves and billows are undulating to rolling areas of sand which presen unlike the waves of a rough sea.

MS—SURFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRA

2	Plan-Profile Units	TYPICAL GEOMETR Range at Yuma / Range in Middl Slope Occurrence Units 1 / 2 / 3 / 4 / 5 Number of slopes greater than 30% per 10 miles 1 / 5 / 20 / 100 / 2
onsiderable size	•NA	NA
formed at the base of	NA NA	NA NA
orm to the windward of	7 7	Lacking Lacking
nd which form to the lee-	7 7	Lacking Lacking
n. They are normally	This phenomenon is classed as a surface condition and considered in terms of surface rou height from 1 or 2 inches to 3 feet and are spaced at intervals of several inches to 4 or 5 fe	
in or plateau nd.	NA	NA
topography.		
facing the wind and horns convex side and the	4 4, (5, 6) 4, (5, 6)	
e into types.	4 4 4, · i, (5, 5i, 5, · 5i, 6, 6i, 6, · 6i)	
intersect the windward w known as a fuji. The k.	4 4 4	
nverse to the direction of mparatively gentle.	4L 4L, 4L, 5L, 5L 4L, 4L, (5L, 5L, 6L, 6L)	
direction, are shaped like face expression on broad	4, 4, (5, 5, 6, 6) 4, 4, (5, 5, 6, 6)	
acterized by curved slopes. e usually associated with neral crest level.	4 4	
which swells and rises avy crest. The profile or slipface. Longitudi-	(5L, 6L) 4, 4L, 5L, 5L, 6L, 6L	
ert a surface not		

PHOTOGRAPHS



21	**Barchans.** Barchans are dunes having a crescentric ground plan with the convex side extending leeward. The profile is asymmetric with the gentler slope on the steeper slope on the concave or leeward face.
22	**Complex dunes** Complex dunes are irregular masses of sand not readily classifiab
23	**Peak and fuji:** These occur where the tips or horns of a fast-moving barchan join or side of another barchan, thus forming a circular or horseshoe-shaped hollo crest of the barchan slipface which flanks the fuji is referred to as the pea
24	**Transverse dunes:** Transverse dunes are strongly asymmetric ridges extending tra dominant sand-moving winds. The leeward slope is steep; the windward, co
25	**Dome-shaped dunes:** Dome-shaped dunes, formed as a result of highly varying wind broad circular upwarps. Barchan dunes often constitute the secondary surf dome-shaped dunes.
26	**Dune massifs.** Dune massifs are massive, roughly conical or pyramidal dunes chara Small hollows and terraces often dimple their steep sides. The massifs are longitudinal dunes, but are quite unmistakable as they rise far above the ger
27	**Longitudinal dunes.** Longitudinal dunes usually consist of a single continuous ridge w at regular intervals to form a chain of summits connected by a continuous w is asymmetric with one side exhibiting a moderate slope, the other, a steep nal dunes are aligned parallel to dominant sand-moving winds.
28	**Waves and billows** Waves and billows are undulating to roll g areas of sand which pres unlike the waves of a rough sea.

Not applicable
Circled plan-profile designations indicate gross landscapes

* Underlined plan
** Raised numbers

15. A salt lake fringed by white, crystalline salt

16. Steeply sloping talus cone flanking a plateau escarpment

17. A large climbing encroaching on a

23. Peak and fuji topographs in the Yuma Sand Hills, Arizona

24. Transverse dunes in the vicinity of Delta, Utah

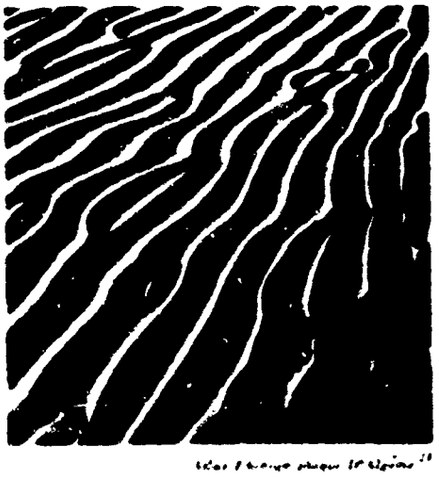
25. A vertical photo dome-shaped dunes light, roughly circular

	4, 5, 6		
to types.	4 4 4, 4L, 5, 5L, 5L, 5L, 6, 6L, 6L, 6L		
ersect the windward own as a fulji. The	4 4 4		
rse to the direction of ratively gentle.	4L 4L, 4L, 5L, 5L 4L, 4L, 5L, 5L, 6L, 6L		
ction, are shaped like expression on broad	4, 4, 5, 5, 6, 6 4, 4, 5, 5, 6, 6		
ized by curved slopes. ally associated with l crest level.	4 4		
swells and rises crest. The profile ipface. Longitudi-	5L, 6L 4, 4L, 5L, 5L, 6L, 6L		
a surface not	7, 4 7, 4	Lacking Lacking	

file designations indicate that the [illegible] in both gross and restrictive landscapes
er to similarly numbered entries [illegible] bibliography at the end of volume I of this report

d drift
n front

18. Cliffs covered b[illegible] falling sand drift cast of Point Ar[illegible]uevo, Calif.



19. Rippled surfaces

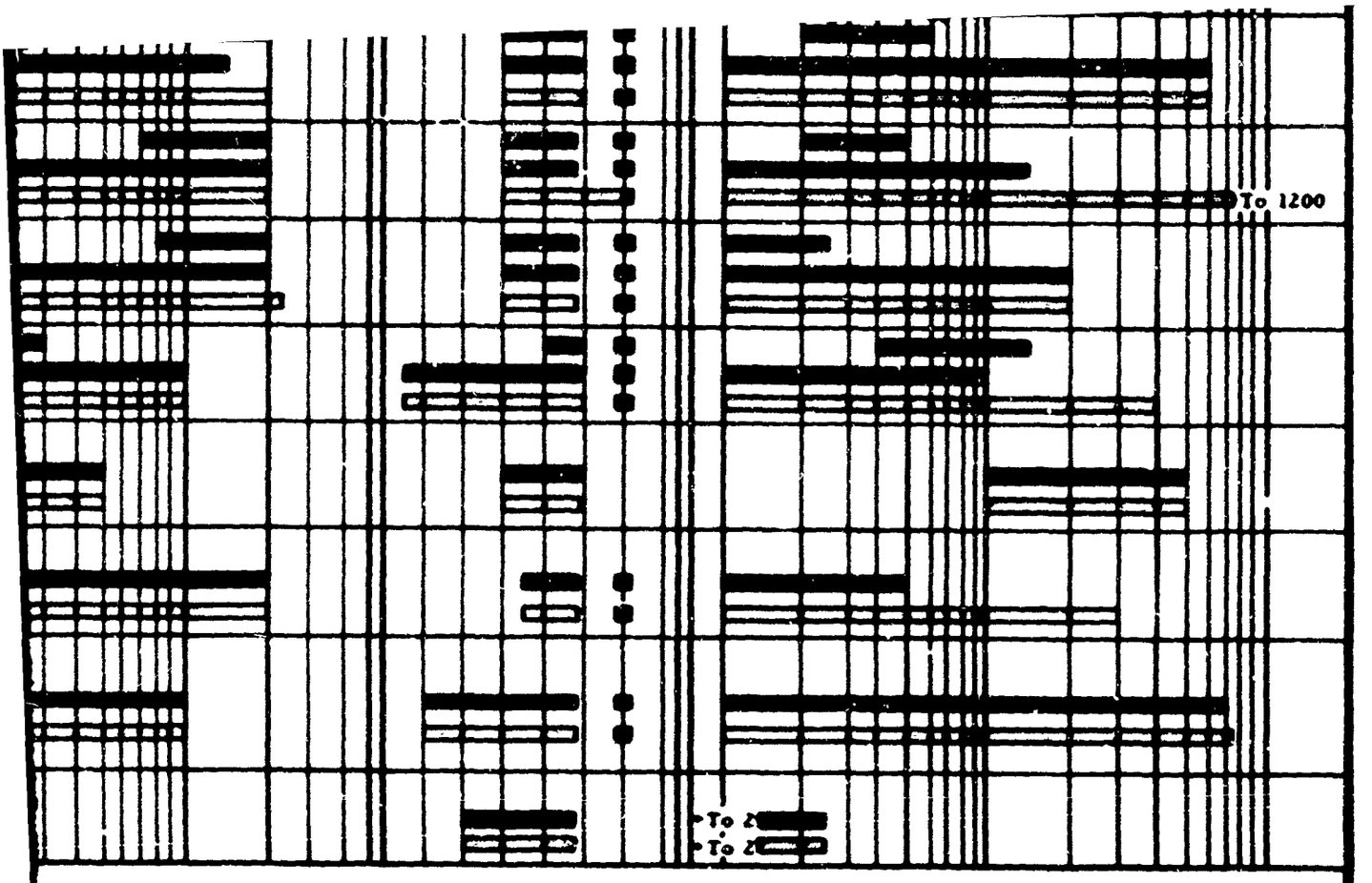
20. Sand-choked wadis appear as white bands which weave through t highly dissected plateau

ith
g as the

26. Dune massi[illegible]rated by sandy plains

27. The sinuous crest line of a longitudinal dune

28. Sand waves and billows rising above a sandy plain



decussed wadis appear as
ds which weave through the
ssected plateau

21. A field of barchan dunes north of Magdalena Bay, Mexico

22. A vertical photograph of a complex dune field in Algeria

n waves and billows rising
sandy plain

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	I. DEPOSITIONAL (CONT.)
	LACUSTRINE
29	Lacustrine terraces: Terraces which mark the shore lines of ancient lakes, or earlier high-water sta existing lakes. They have nearly horizontal surfaces with relatively steep slopes facing the c portion of the lake.
	MARINE
30	Beaches: Beaches are gently sloping strips of land bordering the sea, usually recognized as that part lies between high- and low-water marks and formed by the action of the sea.
31	Mangrove swamps: Salt or brackish swamps along the coast where there are abundant mangrove trees
32	Tidal mud flats: Marshy or muddy lands overed and uncovered by the rise and fall of the tide.
	ORGANIC-CHEMICAL
33	Caliche: Caliche is a calcareous deposit occurring at or near the surface which has accumulated from calcium charged groundwater moving upward and evaporating.
	Playas: Playas are nearly flat areas of salt or salty fine-grained soils occupying basins where water and evaporates after moderate or torrential rains.
34	Dry: Dry playas are characterized by very hard, smooth, flat surfaces of fine-grained soil.
	Moist: Moist playas are characterized by irregular, puffy surfaces with a thin friable surface crus is underlain by soft, spongy ground.
35	Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.
36	Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.
37	Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces are so ne level of the mean high tide that they are covered by the majority of high tides.
	II. EROSIONAL
	GROUNDWATER
38	Caves and caverns: Caves or caverns are natural cavities or chambers beneath the surface. In lime areas they are often connected by underground solution channels formed by subterranean wa
39	Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting underground caves surface. They are typically formed by solution in limestone areas.
40	Karst topography: Karst topography is developed in limestone regions by the solution action of groun surface waters. In advanced stages, the topography is irregular and characterized by numer and depressions of all sizes interspersed with abrupt ridges and irregular protuberant rocks
41	Sinks: Sinks are circular or elongate depressions of varying size formed by solution and collapse in limestone or evaporite rock.

* Not applicable

?? Raised numbers refer to similarly numbered entries in the bibliography at the end of volume 3 of this rep

ORMS—SURFACE CONDITIONS: DESCRIPTIONS AND PHOTOG

2

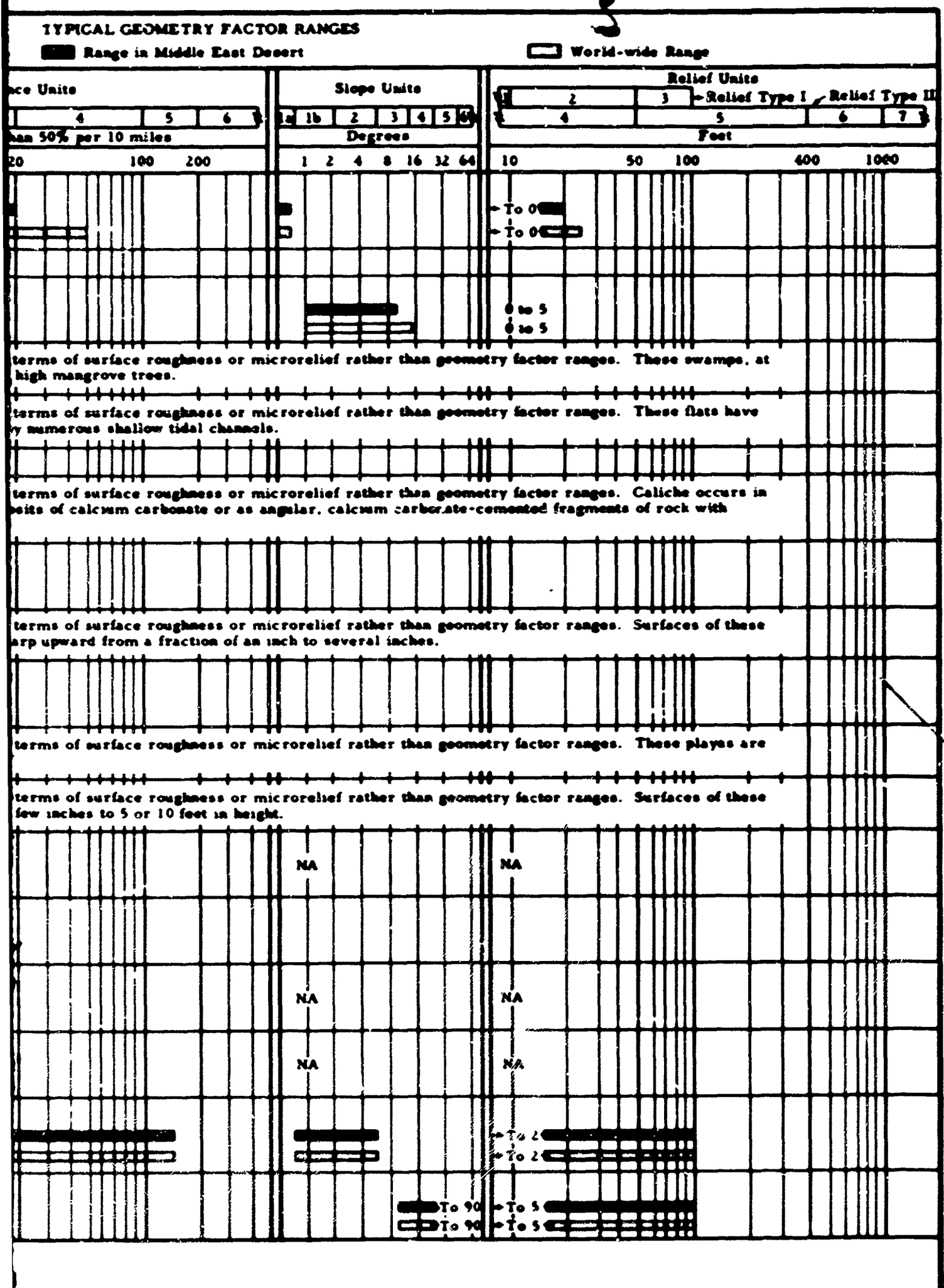
TYPICAL GEOM

Range at Yuma | Range in Mi

	Plan-Profile Units	Slope Occurrence Units 1 | 2 | 3 | 4 | 5 Number of slopes greater than 50% per 10 miles 1 | 5 | 20 | 100
r high-water stages of lopes facing the central	7 7, 3	→ To 0 → To 0
ized as that part which	7 7	Lacking Lacking
t mangrove trees.	This phenomenon is classed as a surface condition and considered in terms of surface rou low tide, are impenetrable tangles of roots and knees, surmounted by high mangrove trees.	
of the tide.	This phenomenon is classed as a surface condition and considered in terms of surface rou relatively smooth surfaces of low bearing capacity and are indented by numerous shallow	
accumulated from	This phenomenon is classed as a surface condition and considered in terms of surface rou most desert areas within plains of gentle slope. It may occur as deposits of calcium carb diameters up to several inches.	
ins where water collects		
ined soil.	This phenomenon is classed as a surface condition and considered in terms of surface rou playas are characterized by dessication polygons whose edges may warp upward from a	
able surface crust which		
f clay.	This phenomenon is classed as a surface condition and considered in terms of surface rou characterized by slightly rolling and spongy surfaces.	
salt.	This phenomenon is classed as a surface condition and considered in terms of surface rou playas are characterized by soft, puffy mounds or pinnacles of salt a few inches to 5 or	
riaces are so near the e.	*NA	NA
surface. In limestone subterranean water.	NA	NA
nderground caves with the	NA	NA
e action of ground and terized by numerous sicke protuberant rocks.	1 1	
and collapse in areas of	NA NA	NA NA

ume I of this report

PHOTOGRAPHS



35	Clay-encrusted: Clay-encrusted playas are moist playas with a surface crust of clay.
36	Salt-encrusted: Salt-encrusted playas are moist playas with a surface crust of salt.
37	Salt marsh: Salt marshes are flat, poorly drained parts of a coastal region whose surfaces ar level of the mean high tide that they are covered by the majority of high tides.
	II. EROSIONAL
	GROUNDWATER
38	Caves and caverns: Caves or caverns are natural cavities or chambers beneath the surface. areas they are often connected by underground solution channels formed by subterrar
39	Chimneys: Chimneys are vertical shafts, with a variety of plan shapes, connecting undergrou surface. They are typically formed by solution in limestone areas.
40	Karst topography: Karst topography is developed in limestone regions by the solution action o surface waters. In advanced stages, the topography is irregular and characterized b and depressions of all sizes interspersed with abrupt ridges and irregular protuberan
41	Sinks: Sinks are circular or elongate depressions of varying size formed by solution and colla limestone or evaporite rock.

- Not applicable
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of t

29. Several flat-topped, steep-fronted lacustrine terraces flanking a mountain range in Utah

30. A narrow beach bounded by the vegetated coastal plain and the sea

31. Mangrove swamps bo the Gulf of Siam in southe insula, Thailand

37. Salt marsh

38. Entrance to Carlsbad Caverns in southeastern New Mexico

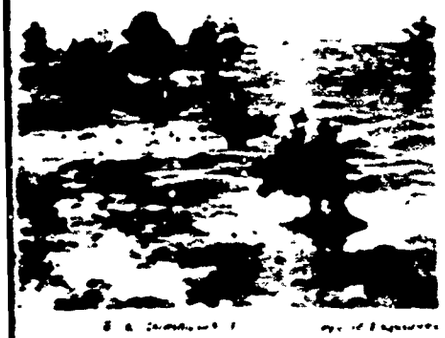
NO PHOTOGRAPH AVAILABLE

39. Chimneys

characterized by slightly rolling and spongy surfaces.

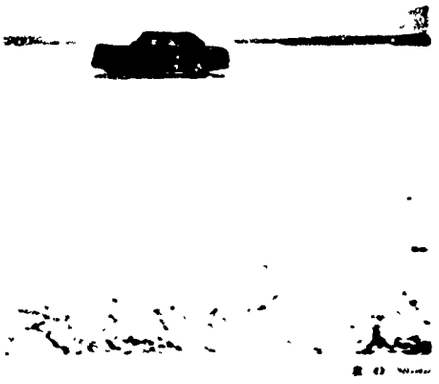
This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief ; playas are characterized by soft, puffy mounds or pinnacles of salt a few inches to 5 or 10 feet in height.

	NA	NA	NA
	NA	NA	NA
he	NA	NA	NA
kr			
f	NA NA	NA NA	



32. Tidal mud flat at the mouth of the Chao Phraya River, coastal Thailand

33. The light-colored caliche is overlain by a dark sandy clay layer



34. Desiccation cracks on the surface of a dry playa

35. clay-

40. A vertical photograph of Karst topography in a limestone plateau area

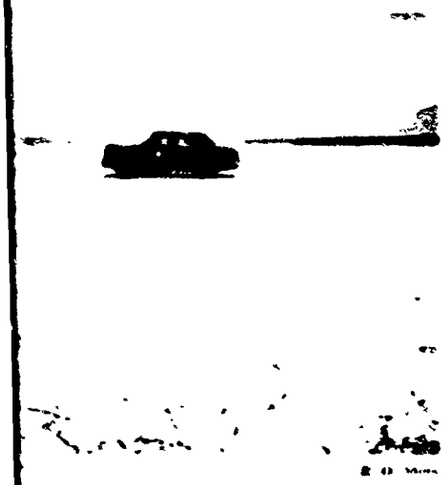
41. A sink as viewed from the rim

LA

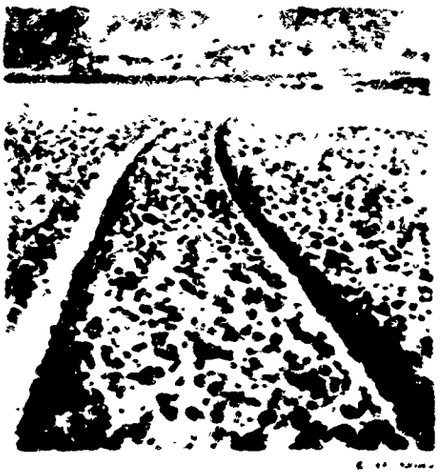
in terms of surface roughness or microrelief rather than geometry factor ranges. These playas are

in terms of surface roughness or microrelief rather than geometry factor ranges. Surfaces of these
a few inches to 5 or 10 feet in height.

	NA	NA	
	NA	NA	
	NA	NA	
		To 2	
		To 2	
	To 90	To 5	
	To 90	To 5	



34. Desiccation cracks on the surface of a dry playa



35. Soft and spongy surface of a clay-encrusted playa

36. Rough surface of a salt-encrusted playa

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	II. EROSIONAL (CONT.) MARINE
42	Wave-cut cliffs: Steep cliffs of bare rock, or occasionally unindurated materials, marking the seaward limit of the coast.
43	Wave-cut terraces: Steplike, narrow strips of land adjacent to or near the sea wh the waves and current. Each terrace records a landward advance of litto
	SURFACE WATER
44	Amphitheatres: Amphitheatres are semicircular erosion bays, formed at the head often scallop plateau scarps in arid regions.
45	Aqabas: Aqabas are gaps in asymmetrical ridges which connect basins of differen between the ridges.
46	Badlands: Regions nearly devoid of vegetation where erosion, instead of carving h dinary type, has cut the land into an intricate maze of narrow ravines, sha
47	Buttes and mesas: Isolated residual prominences with very steep or precipitous s remnants of a plateau area. Mesas have distinctively flat tops; buttes have small flat tops or peaks remain.
48	Canyon country: Canyon country refers to a plateau dissected by a branching netw valleys.
49	Flatirons: Triangular remnants of an eroded hogback ridge often occurring in ser mountain.
50	Foothills: Foothills are lower subsidiary hills at the foot of mountains or higher zones between the highlands and the adjacent lower land.
51	Hogbacks: Hogbacks are sharp-crested ridges produced by unequal erosion in ste
52	Incised meanders: Incised meanders are deep, sinuous valleys cut by rejuvenated course having been acquired in a former cycle.
53	Knife-edged spurs Sharp-crested rock ridges forming interstream divides which tain masses.
54	Outliers: Isolated remnants of rock detached from the main mass.
55	Pediments: Pediments are relatively smooth rock plains gently inclined away fro They are sometimes partly covered by a thin veneer of alluvium.

* Not applicable
** Circled plan-profile designations indicate gross landscapes
† Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

URFACE CONDITIONS: DESCRIPTIONS AND PHOTOGRAPHS

2

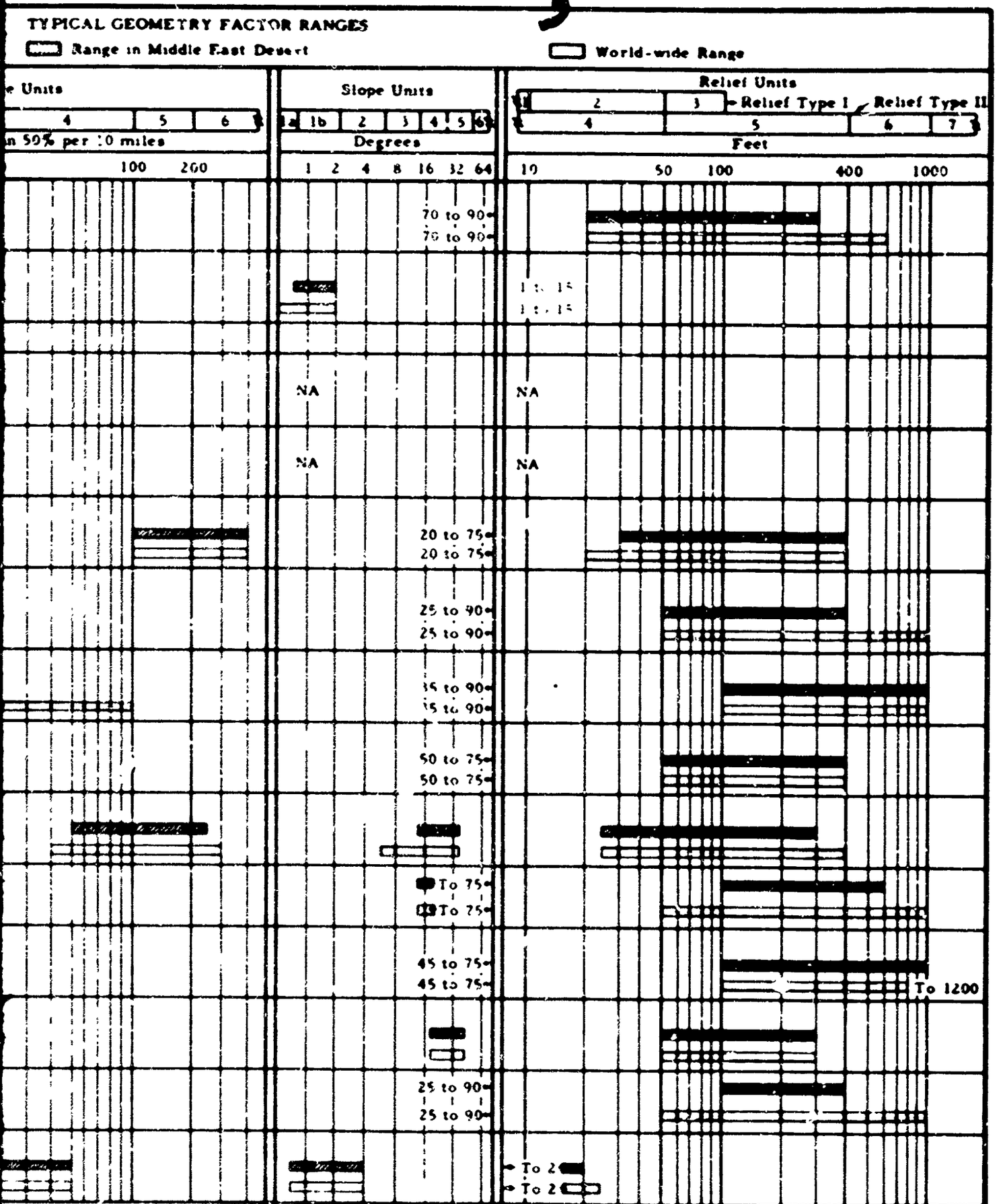
TYPICAL GEOMETRY FACTOR RA

Range at Yuma

Range in Middle East Desert

	Plan-Profile Units	Slope Occurrence Units: 1 / 2 / 3 / 4 / 5 / 6 — Number of slopes greater than 50% per 10 miles: 1 / 5 / 20 / 100 / 200
erosion	*NA NA	NA NA
red by	7, 1 7, 1	→ To 0 → To 0
hich	NA	NA
r	NA	NA
o-- cles.	4 4	
l only	[illegible]	
alled	[illegible]	
	7 7	Lacking Lacking
sitional	4, 4L 4, 4L	
	[illegible]	
ring	NA NA	NA NA
moun-	[illegible] [illegible]	→ To 0
	[illegible]	
sses.	1, 1L 1, 1L	

PHOTOGRAPHS



49	Flatirons Triangular remnants of an eroded hogback ridge often occurring in series on the flank of a mountain.
50	Foothills Foothills are lower subsidiary hills at the foot of mountains or higher hills. They form tran zones between the highlands and the adjacent lower land.
51	Hogbacks Hogbacks are sharp-crested ridges produced by unequal erosion in steeply inclined rock.
52	Incised meanders Incised meanders are deep, sinuous valleys cut by rejuvenated streams, the meande course having been acquired in a former cycle.
53	Knife-edged spurs Sharp-crested rock ridges forming interstream divides which extend outward from tain masses.
54	Outliers Isolated remnants of rock detached from the main mass.
55	Pediments Pediments are relatively smooth rock plains gently inclined away from hill or mountain m They are sometimes partly covered by a thin veneer of alluvium.

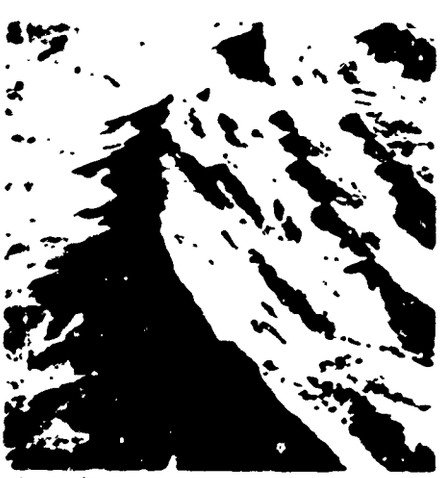
Not applicable
Circled plan-profile designations indicate gross landscapes
* Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
** Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

42. Wave-cut cliffs

41. A wave-cut terrace surmounted by several stacks

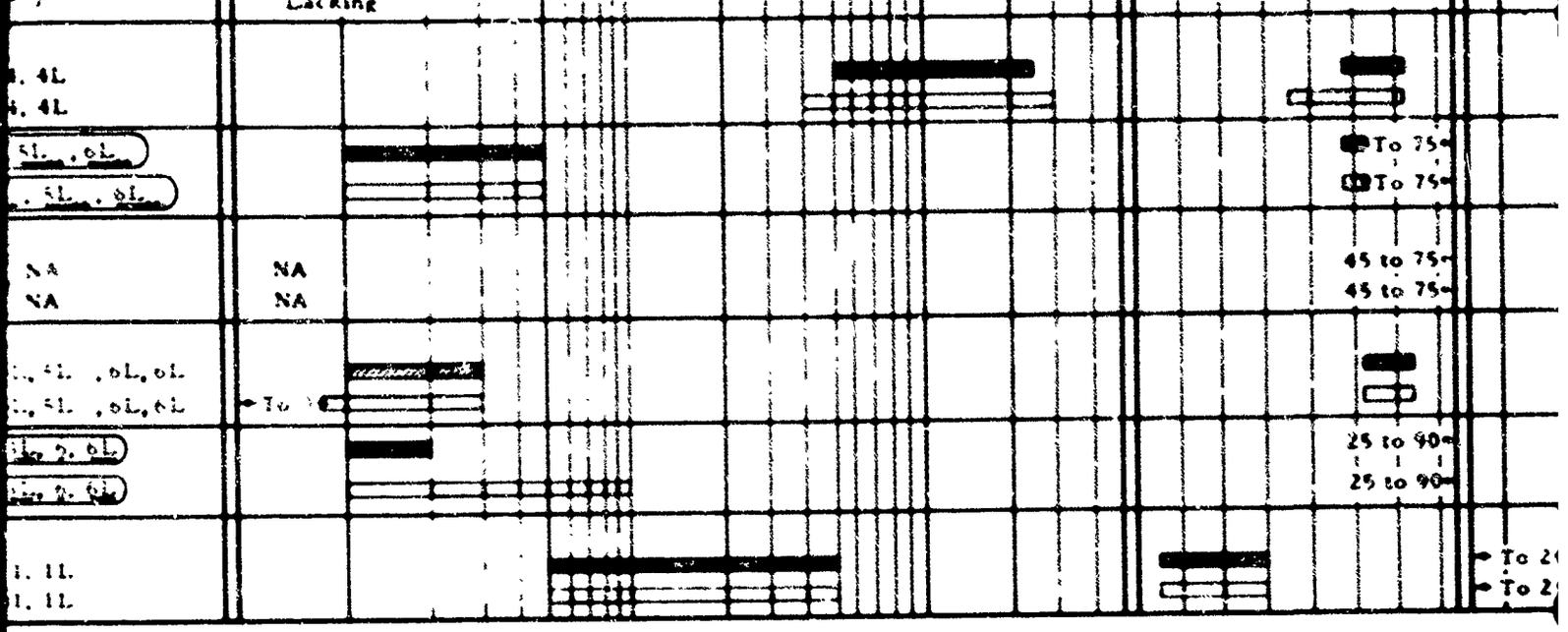
44. Two well-developed amphitheatres in the face of an escarpment

50. Foothills



51. Hogbacks

52. The valley of the San Juan River, Utah, incised to a depth of 1200 ft into the plateau



ing through

46. Badlands

47. Buttes and mesas

48. Canyon country

along west
, northeast

54. Outliers

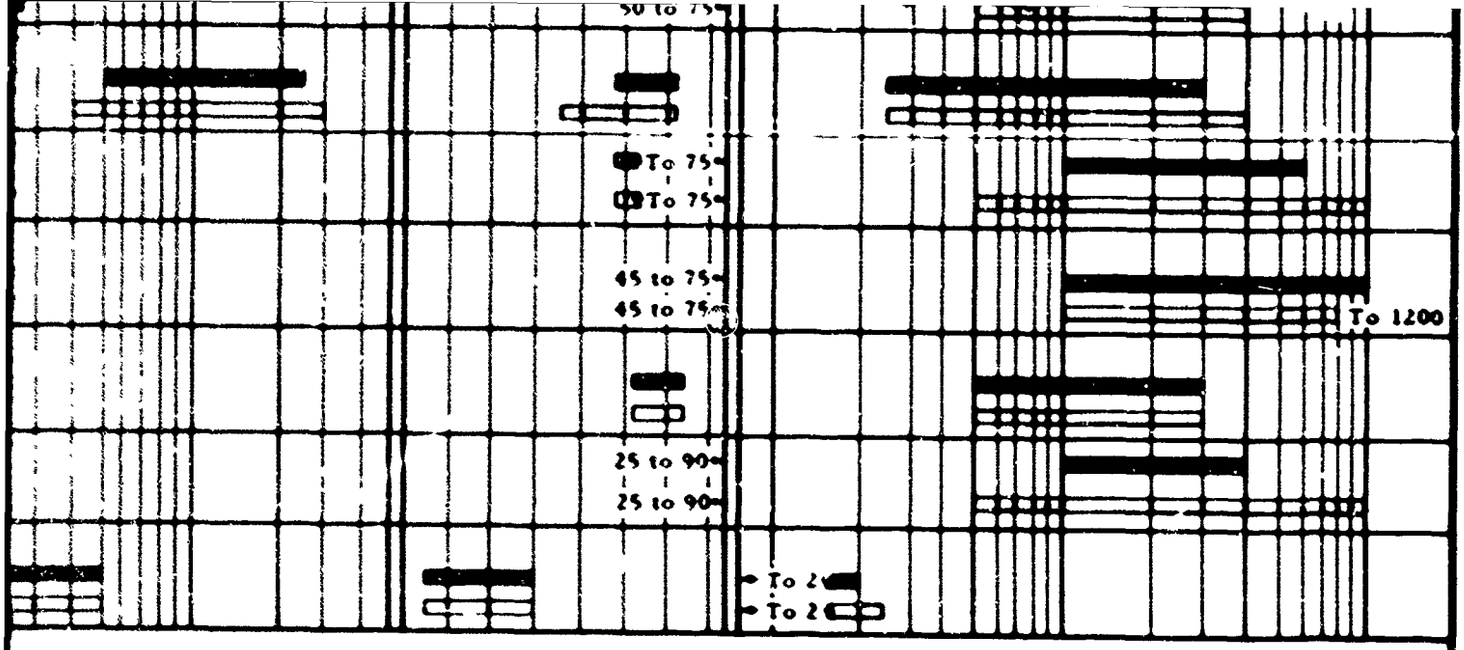
55. A gently sloping pediment flanking the Grand Atlas Mountain in southern Morocco

ANALOG

MIDI

LANDFORMS-

DESCRIPTIO



47 Buttes and mesas

48. Canyon country

49. Flatirons

gently sloping pediment flank-
e Grand Atlas Mountain in
err Morocco

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

PLATE 19C

Photo No.	CLASSIFICATION AND DESCRIPTION
	II. EROSIONAL (CONT.)
	SURFACE WATER
	Random hills. Randomly oriented masses rising less than 1,000 feet above the level of the surrounding country.
56	Consolidated random hills: Consist of masses of sedimentary, igneous, or metamorphic rock.
57	Unconsolidated random hills Consist of unconsolidated material such as clay, silt, sand, or grav
58	Rock terraces Rock terraces are relatively narrow benches left when a stream cuts a new valley be level of the erosional plain which is cut into the bedrock.
59	Scarps. Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of rel
60	Steep wadi banks Steep wadi banks are mapped where a conspicuous number of wadies bordered by precipitous banks occur. Wherever banks are higher than 100 feet they are considered sca
	WIND
61	Desert pavement Desert pavement is a mosaic of closely packed pebbles and broken rock fragment coated with a stain or crust of manganese or iron oxide.
62	Flint-strewn plains Flint-strewn plains are flat to undulating surfaces developed on weathered lim chalk. They are characterized by scattered pebbles and sharp-edged chips of flint weath parent rock.
63	Hamadas Hamadas are extensive, flat to undulating surfaces of bedrock or bedrock covered by a th of pebbles or rock fragments.
64	Wind-scored sandstone surfaces Knobby, knotty surfaces of horizontal sandstone created by the ab action of sand-laden wind
	III. MISCELLANEOUS
	INTRUSIVE
65	Dikes Wall-like intrusions of igneous rock which cut across the bedding or other layered structur country rock On eroding they commonly form narrow, sharp-crested ridges which may r miles across country
66	Knobs Knobs are rounded, isolated hills or small mountains. They usually constitute the surface of weathered plutonic intrusions.
	METEORIC
67	Meteorite craters Steep-walled, saucer-shaped depressions produced by the impact and accompan plosion of an object of extraterrestrial origin.
	RESIDUAL
68	Exfoliated boulders A term applied to boulders whose surfaces have broken or peeled off as scale or concentric sheets
69	Grus The accumulation of countless discrete particles on the surface sometimes extending to dep greater than 10 feet formed from weathering of the various minerals composing the roc

• Not applicable.

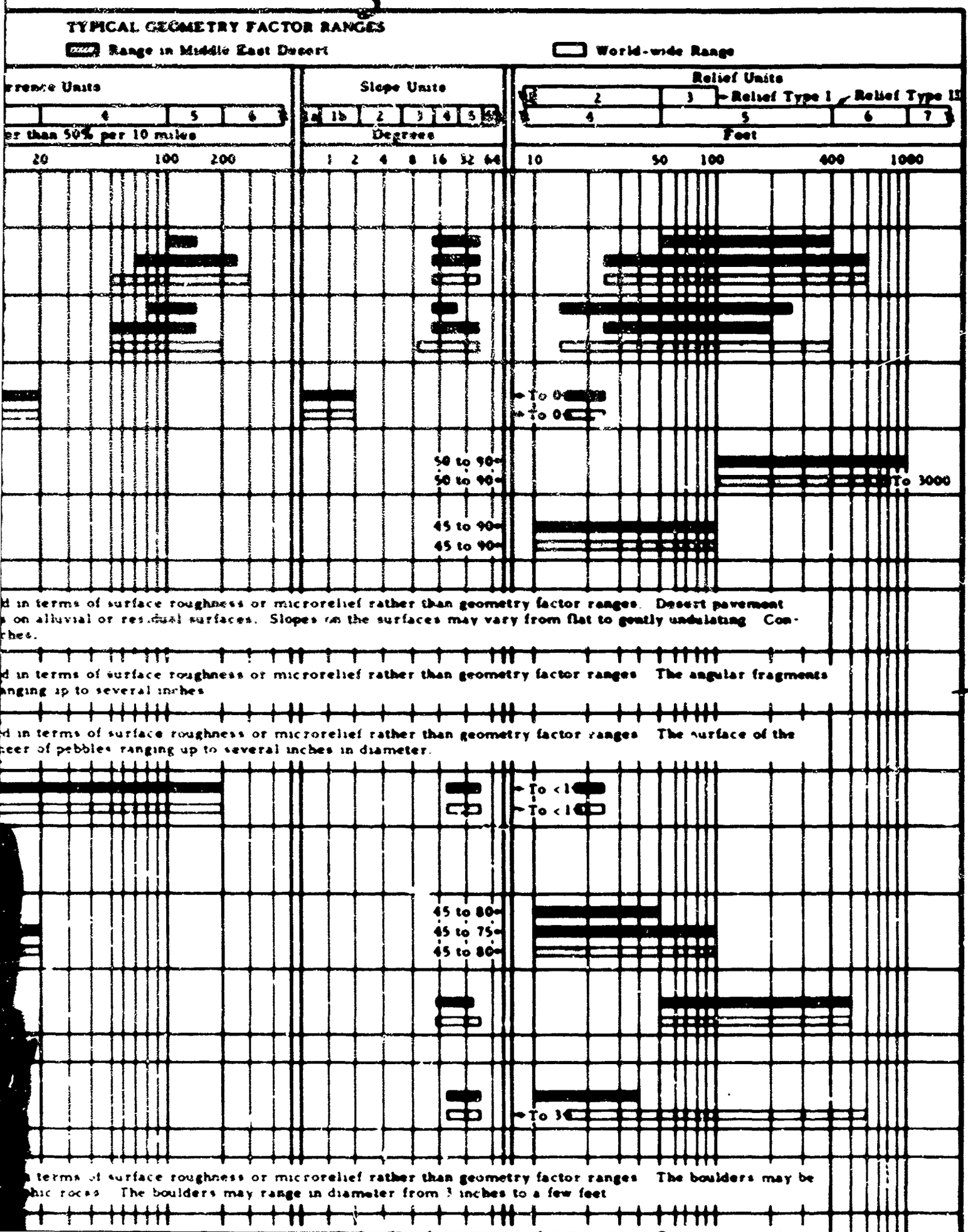
NDFORMS – SURFACE CONDITIONS: DESCRIPTIONS AND PHOT

1

Range at Yuma — TYPICAL Ran

	Plan-Profile Units	Slope Occurrence Units: 1 / 2 / 3 / 4 — Number of slopes greater than 50% per I: 1 / 5 / 20
e level of the surrounding		
metamorphic rock.	4 4, 4L 4, 4L	
clay, silt, sand, or gravel.	4 4, 4L 4, 4L	
dam cuts a new valley below the	7, 1 7, 1	To 0 To 0
more than 100 feet of relief.	*NA NA	NA NA
of wadies bordered by high they are considered scarps.	NA NA	NA NA
d broken rock fragments usually	This phenomenon is classed as a surface condition and considered in terms of surf occurs as a thin veneer of closely fitted gravel or rock fragments on alluvial or re stitutent particles may exhibit maximum diameters of several inches.	
loped on weathered limestone or ed chips of flint weathered from the	This phenomenon is classed as a surface condition and considered in terms of surf and chips of flint which cover these plains may have diameters ranging up to sever	
bedrock covered by a thin veneer	This phenomenon is classed as a surface condition and considered in terms of hamada is flat to gently undulating and may be covered with a veneer of pebbles ra	
stone created by the abrasive	4, 5, 7 4, 5, 7	Lacking Lacking
other layered structure of the ed ridges which may run fo-	4L 4L, 5L, 6L 4L, 5L, 6L	
constitute the surface expression	4, 5, 6 4, 5, 6	
e impact and accompanying ex-	NA NA	NA NA
or peeled off as scales, lamellae,	This phenomenon is classed as a surface condition and considered in terms of surf angular or rounded fragments of igneous, sedimentary, or metamorphic rocks. TY	
times extending to depths e composing the rock	This phenomenon is classed as a surface condition and considered in terms of surf angular fragments of weathered granite which may exhibit maximum diameters of	

ND PHOTOGRAPHS



d in terms of surface roughness or microrelief rather than geometry factor ranges. Desert pavement
s on alluvial or residual surfaces. Slopes on the surfaces may vary from flat to gently undulating. Con-
hes.

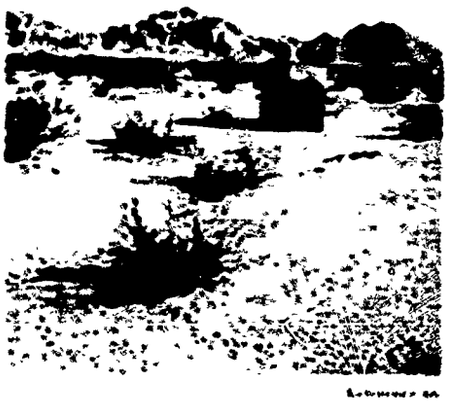
d in terms of surface roughness or microrelief rather than geometry factor ranges. The angular fragments
nging up to several inches

d in terms of surface roughness or microrelief rather than geometry factor ranges. The surface of the
eer of pebbles ranging up to several inches in diameter.

terms of surface roughness or microrelief rather than geometry factor ranges. The boulders may be
hic rocks. The boulders may range in diameter from 3 inches to a few feet

63	**Hamadas:** Hamadas are extensive, flat to undulating surfaces of bedrock or bedroc of pebbles or rock fragments.
64	**Wind-scored sandstone surfaces:** Knobby, knotty surfaces of horizontal sandstone action of sand-laden wind.
	III. MISCELLANEOUS
	INTRUSIVE
65	**Dikes:** Wall-like intrusions of igneous rock which cut across the bedding or other country rock. On eroding they commonly form narrow, sharp-crested rid miles across country.
66	**Knobs:** Knobs are rounded, isolated hills or small mountains. They usually consti of weathered plutonic intrusions.
	METEORIC
67	**Meteorite craters:** Steep-walled, saucer-shaped depressions produced by the impa plosion of an object of extraterrestrial origin.
	RESIDUAL
68	**Exfoliated boulders:** A term applied to boulders whose surfaces have broken or pe or concentric sheets.
69	**Grus:** The accumulation of countless discrete particles on the surface sometimes greater than 10 feet formed from weathering of the various minerals comp

• **Not applicable.** †† Raised numbers refer to similarly numbered entries



56. Rugged, crystalline hills rising above a desert plain

57. Unconsolidated hills near Yuma, Arizona

58. Rock-cu south of Wen

NO PHOTOGRAPH AVAILABLE

64. Wind-scored sandstone surfaces

65. View along a ridge cut by dikes

66. A granite above a desert

	This phenomenon is classed as a surface condition and consi hamada is flat to gently undulating and may be covered with	
ce of horizontal sandstone created by the abrasive	4, 5, 7 4, 5, 7	Lacking Lacking
cross the bedding or other layered structure of the narrow, sharp-crested ridges which may run for	4L 4L, 5L, 6L 4L, 5L, 6L	
ntains. They usually constitute the surface expression	4, 5, 6 4, 5, 6	
sions produced by the impact and accompanying ex-	NA NA	NA NA
surfaces have broken or peeled off as scales, lamellae,	This phenomenon is classed as a surface condition and consid angular or rounded fragments of igneous, sedimentary, or me	
on the surface sometimes extending to depths the various minerals composing the rock.	This phenomenon is classed as a surface condition and consid angular fragments of weathered granite which may exhibit ma	

similarly numbered entries in the bibliography at the end of volume I of this report

58. Rock-cut terraces 10 miles south of Wendover, Nevada

59. Santa Helena scarp of the Grand Canyon de Santa Helena, Brewster County, Texas

60. Steep wadi banks

66. A granite knob rising abruptly above a desert plain

67. The famous Arizona meteor crater

68. A close-up of an exfoliated boulder showing the typical spalling action

4, 5, 7	Lacking	
4, 5, 7	Lacking	
4L		45 to 80+
4L, 5L, 6L		45 to 75+
4L, 5L, 6L		45 to 80+
4, 5, 6		
4, 5, 6		
NA	NA	
NA	NA	

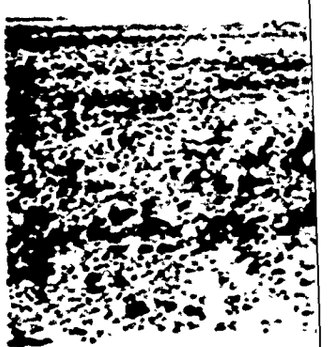
phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than geometr
ar or rounded fragments of igneous, sedimentary, or metamorphic rocks. The boulders may range in diameter from 3 inches t

phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rather than geometr
ar fragments of weathered granite which may exhibit maximum diameters of several feet.

...t report

60. Steep wadi banks

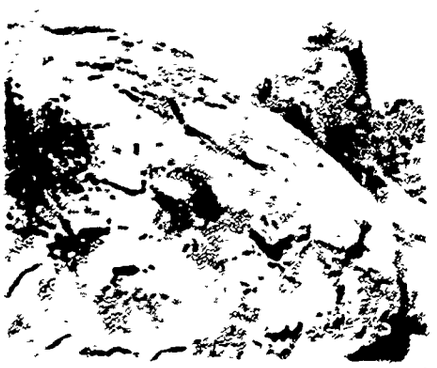
61. A smooth surface of desert pavement. The tire tracks have penetrated the underlying silt



62. Flint-strewn pla

...the Grand
...Brewster

...meteor



68. A close-up of an exfoliated boulder showing the typical spalling action

69. Grus deposit resulting from weathering of igneous rock

ANAL

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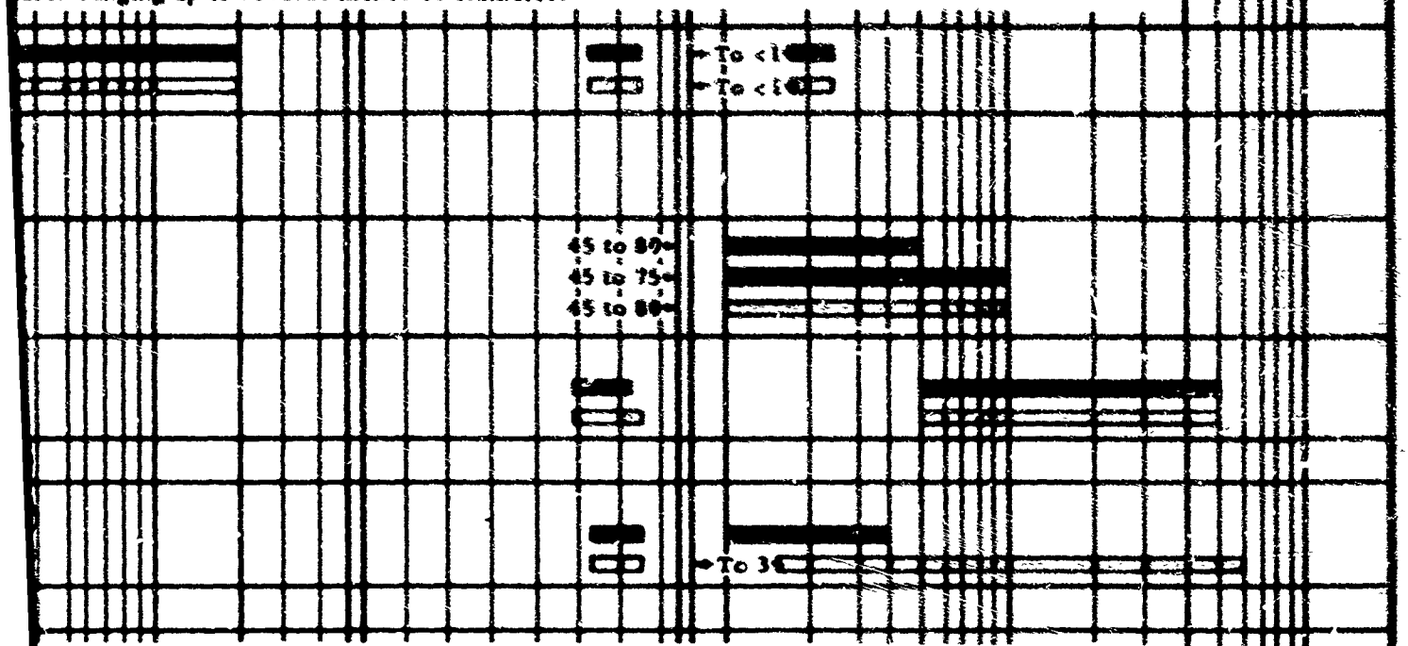
LANDFORMS

DESCRIPT

6

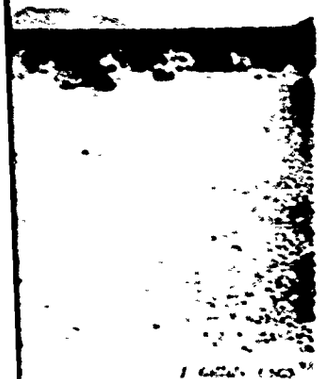
of surface roughness or microrelief rather than geometry factor ranges. The angular fragments o several inches.

of surface roughness or microrelief rather than geometry factor ranges. The surface of the bles ranging up to several inches in diameter.



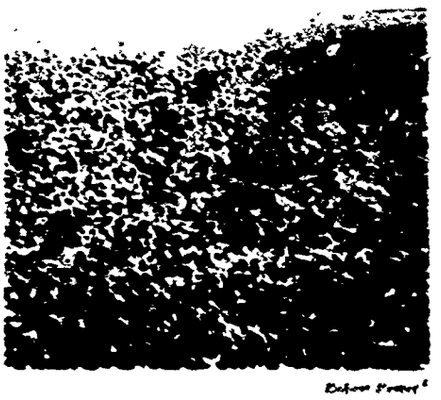
f surface roughness or microrelief rather than geometry factor ranges. The boulders may be s. The boulders may range in diameter from 3 inches to a few feet.

f surface roughness or microrelief rather than geometry factor ranges. Grus consists of rs of several feet.



ooth surface of desert
. The tire tracks have
d the underlying silt

62. Flint-strewn plains



63. The rocky surface of a hamada

leposit resulting from
of igneous rock

ANALOGS OF YUMA TERRAIN
IN THE
MIDDLE EAST DESERT

LANDFORMS-SURFACE CONDITIONS

DESCRIPTIONS AND PHOTOGRAPHS

Photo No.	CLASSIFICATION AND DESCRIPTION
	III. MISCELLANEOUS (CONT.) TECTONIC
70	Basin ranges: Ranges of hills or mountains formed by faulted and tilted blocks of strata (separated
71	Domal warps: Domal warps are roughly circular upwarps with beds dipping away from a central poi surface expression is often that of centrally facing, concentric series of erosional scarps.
72	Drowned valleys: Drowned valleys are erosional troughs of a dissected land surface inundated by the result of land-margin submergence.
73	Elongate domes: Elongate domes are elliptical upfolds, the beds dipping away from centrally located
74	Intramontane valleys: Intramontane valleys are narrow valleys or troughs with exterior drainage by mountains.
75	Scarps: Scarps are more or less continuous, precipitous slopes exhibiting more than 100 feet of reli
	VOLCANIC
76	Broken lava flows: Flat to undulating lava areas characterized by sharp-edged rocks and boulders.
77	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash or clinker-rial around a vent.
78	Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed of volcanic that has mantled the pre-existing landscape.
79	Craters and Calderas: Bowl- or funnel-shaped depressions of volcanic origin which are more or less in plan and rimmed by an infacing scarp. Craters are commonly less than a mile in diameter calderas have diameters several times larger.
80	Lava flows: Lava flows are solidified stationary masses of igneous rock which issued from a volcanic fissure.
81	Mud volcanoes: Small cone-shaped mounds built of clay and ordinarily formed by the eruption of sulf bituminous mud from a central vent or orifice.
82	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by erosion.

* Not applicable
** Circled plan-profile designations indicate gross landscapes
† Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes
†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report



2

TYPICAL GEOMETRY FACTOR RANGES

Range at Yuma Range in Middle East Desert

Plan-Profile Units	Slope Occurrence Units (Number of slopes greater than 50% per 10 miles: 1 | 2 | 3 | 4 | 5 | 6; 1 | 5 | 20 | 100 | 200)	Slope (Degr: 1 | 2 | 4)
4 4, 4L (5L, 5L//, 6L, 6L//) **†		
6 4, 4L		
•NA	NA	NA
4, 4L 4, 4L		
1, 1L 1, 1L		
NA NA	NA NA	

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe
flow is composed of large, angular blocks of lava having diameters ranging up to several feet.

4, 4//, (5, 5//, 6, 6//)	
4, 4//, (5, 5//, 6, 6//)	

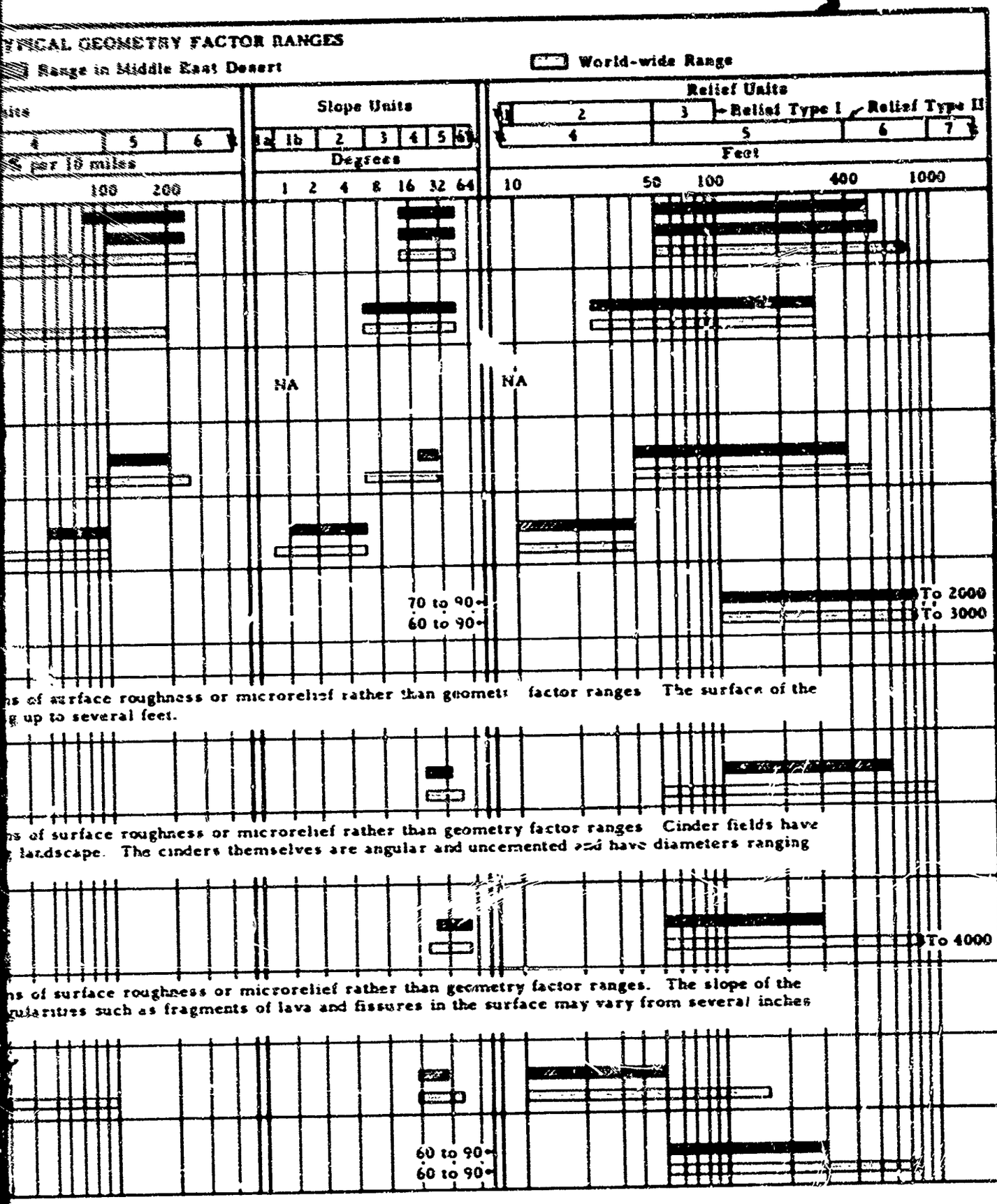
This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe
slopes which are determined to some extent by the underlying, preexisting landscape. The cinders themselves are an
between 4 and 32 mm.

NA NA	NA NA

This phenomenon is classed as a surface condition and considered in terms of surface roughness or microrelief rathe
surface of these flows varies from flat to gently undulating. Surface irregularities such as fragments of lava and fiss
to 10 feet.

4, 4// 4, 4//, (5, 5//, 6, 6//)	
4 4, 4//	

3



ns of surface roughness or microrelief rather than geometr factor ranges The surface of the
g up to several feet.

ns of surface roughness or microrelief rather than geometry factor ranges Cinder fields have
landscape. The cinders themselves are angular and uncemented and have diameters ranging

ns of surface roughness or microrelief rather than geometry factor ranges. The slope of the
gularities such as fragments of lava and fissures in the surface may vary from several inches

76	[illegible] lating lava areas characterized by sharp-edged rocks and b
77	Cinder cones: Cinder cones are conical hills formed by the accumulation of volcanic ash o rial around a vent.
78	Cinder fields: Cinder fields are flat to undulating areas, often miles in extent, composed o that has mantled the pre-existing landscape.
79	Craters and Calderas: Bowl- or funnel-shaped depressions of volcanic origin which are m in plan and rimmed by an infacing scarp. Craters are commonly less than a mile calderas have diameters several times larger.
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82	Necks and plugs: Necks and plugs are lava-filled conduits of an extinct volcano exposed by

Not applicable

( ) Circled plan-profile designations indicate gross landscapes

_ Underlined plan-profile designations indicate that they occur in both gross and restrictive landscapes

†† Raised numbers refer to similarly numbered entries in the bibliography at the end of volume I of this report

70. Basin ranges in the center and background of the photograph separated by alluvial aprons

71. An eroded domal warp forming a topographic basin

72. Drowned v

78. Cinder field at the northern

79. Mt. Edgecomb, Kruzof Island,

80. Lava flow

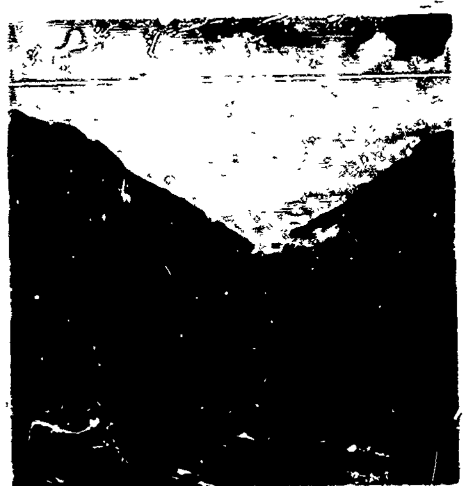
	(5, 5//, 6, 6//)	
...sed of volcanic ejecta	This phenomenon is classed as a surface condition and considered in terms of surface rou... slopes which are determined to some extent by the underlying, preexisting landscape. Th... between 4 and 32 mm.	
...are more or less circular ... mile in diameter, while	NA NA	NA NA
...d from a volcanic cone or	This phenomenon is classed as a surface condition and considered in terms of surface rou... surface of these flows varies from flat to gently undulating. Surface irregularities such a... to 10 feet.	
... eruption of sulfurous and	4, 4/ (5, 5//, 6, 6//)	
...ed by erosion.	4 4, 4//	

Wille[2?]

...ed valleys

...Gévern ... France[32]

73. Vertical photograph of a breached elongate dome with inward dendritic drainage



R. Cross, 1965[31]

74. An intramontane valley

75. Aerial view of Bla... fault scarp furrowed by... south of Mormon, Calif...

...e Department of Agriculture

... with cinder ...ower left

J. T. Hermann[30]

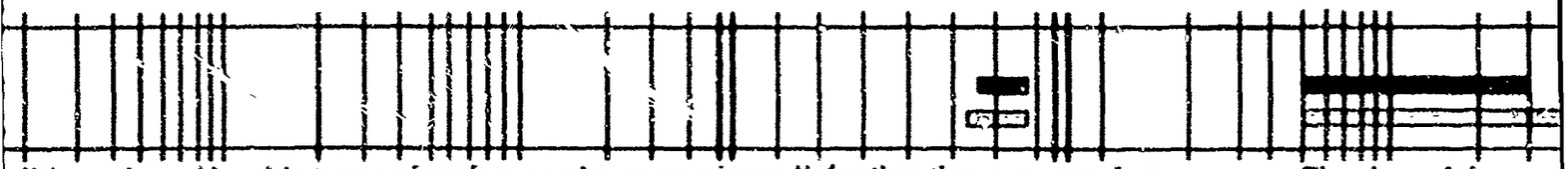
81. A mud volcano rising above the surrounding terrain

Photograph by O.F.A.L.A.C., ... P. Strobel[11]

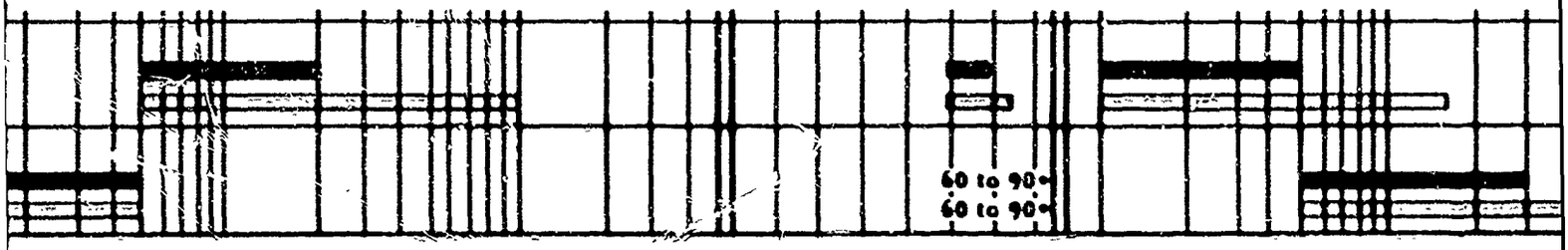
82. Plugs towering over a volcanic region

5

dition and considered in terms of surface roughness or microrelief rather than geometry factor ranges. Cinder fields have by the underlying, preexisting landscape. The cinders themselves are angular and uncemented and have diameters ranging



dition and considered in terms of surface roughness or microrelief rather than geometry factor ranges. The slope of the ntly undulating. Surface irregularities such as fragments of lava and fissures in the surface may vary from several inches

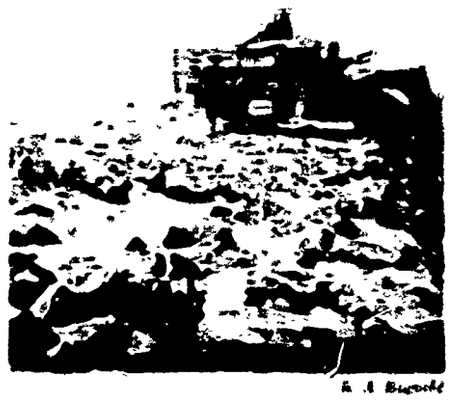


F. Ernst, USGS[53]

ontane valley

Dr. John H. Buzzard

75. Aerial view of Black Mountain fault scarp furrowed by gorges south of Mormon, California



E. A. Bagnold

76. A broken [illegible] partially [illegible] sand

77. Cinder con

. Antevs, P. Beaty[53]

ring over a
n

ANALOGS OF YUMA TERRAIN

IN THE

MIDDLE EAST DESERT

LANDFORMS - SURFACE CONDIT

DESCRIPTIONS AND PHOTOGRAPI

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